

# 60% Construction Documents



# FULLER MIDDLE SCHOOL

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Framingham, Massachusetts

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Boston, Massachusetts 02116

Date of Issue:

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Volume 2 of 2      Divisions 21 to 33 + Appendices



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8/9/19	60%CD	Section 06 16 00	Sheathing
8/9/19	60%CD	Section 06 20 00	Finish Carpentry

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8/9/19	60%CD	Section 09 22 16	Non-Structural Metal Framing
8/9/19	60%CD	Section 09 23 13	Acoustical Gypsum Plaster
8/9/19	60%CD	Section 09 29 00	Gypsum Board
8/9/19	60%CD	Section 09 30 00 *	Tiling (*Trade Contract Required as part of Section 09 00 03)
8/9/19	60%CD	Section 09 30 16 *	Quarry Tiling (*Trade Contract Required as part of Section 09 00 03)
8/9/19	60%CD	Section 09 51 00 *	Acoustical Ceilings (*Trade Contract Required)
8/9/19	60%CD	Section 09 64 66	Wood Athletic Flooring

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8/9/19	60%CD	Section 09 65 13 *	Resilient Base and Accessories (* Trade Contract Required as part of Section 09 00 06)
8/9/19	60%CD	Section 09 65 43 *	Linoleum Flooring (* Trade Contract Required as part of Section 09 00 06)
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8/9/19	60%CD	Section 09 91 00 *	Painting (* Trade Contract Required as part of Section 09 00 09)
8/9/19	60%CD	Document 09 91 13 *	Exterior Painting Schedule (* Trade Contract Required as part of Section 09 00 09)
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<i>Date</i>	<i>Issue</i>	<i>Section Number &amp; Title</i>	
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 CD Pricing Package, Issued 7/8/19..

8/9/19	60%CD	Section 11 57 00	Vocational Shop Equipment
8/9/19	60%CD	Section 11 61 33	Theatrical Rigging
8/9/19	60%CD	Section 11 61 43	Theatrical Draperies
8/9/19	60%CD	Section 11 61 91	Theatrical Lighting Instruments and Accessories
8/9/19	60%CD	Section 11 66 23	Gymnasium Equipment
8/9/19	60%CD	Section 11 66 24	Basketball Equipment
8/9/19	60%CD	Section 11 66 43	Interior Scoreboards
8/9/19	60%CD	Section 11 66 53	Gymnasium Dividers

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<i>Date</i>	<i>Issue</i>	<i>Section Number &amp; Title</i>	
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8/9/19	60%CD	Section 12 24 14	Motorized Window Shades
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<i>Date</i>	<i>Issue</i>	<i>Section Number &amp; Title</i>	
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**VOLUME 2 (DIVISIONS 21 THROUGH 33 + APPENDICES)**

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<i>Date</i>	<i>Issue</i>	<i>Section Number &amp; Title</i>	
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<i>Date</i>	<i>Issue</i>	<i>Section Number &amp; Title</i>	
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8/9/19	60%CD	Section 22 08 00	Commissioning of Plumbing

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<i>Date</i>	<i>Issue</i>	<i>Section Number &amp; Title</i>	
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8/9/19	60%CD	Section 23 08 00	Commissioning of HVAC

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**DIVISION 26 — ELECTRICAL**

<i>Date</i>	<i>Issue</i>	<i>Section Number &amp; Title</i>	
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8/9/19	60%CD	Section 26 08 00	Commissioning of Electrical Systems
8/9/19	60%CD	Section 26 61 11	Theatrical Lighting Controls

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<i>Date</i>	<i>Issue</i>	<i>Section Number &amp; Title</i>	
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05/10/19	ESP	Section 31 23 19	Dewatering
05/10/19	ESP	Section 31 25 00	Erosion & Sedimentation Controls
05/10/19	ESP	Section 31 50 00	Excavation Support and Protection
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05/10/19	ESP	Section 32 16 14	Precast Concrete Curbs
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05/10/19	ESP	Section 32 17 23	Pavement Markings
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<i>Date</i>	<i>Issue</i>	<i>Section Number &amp; Title</i>	
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05/10/19	ESP	Section 33 31 00	Sanitary Utility Sewerage Piping
05/10/19	ESP	Section 33 41 00	Storm Utility Drainage Piping
05/10/19	ESP	Section 33 49 23	Storm Drainage Retention Structures

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**APPENDICES**

<i>Date</i>	<i>Issue</i>	<i>Appendix Number &amp; Title</i>
8/9/19	60%CD	Appendix A LEED Scorecard
8/9/19	60%CD	Appendix B Code Report
8/9/19	60%CD	Appendix C Foodservice Cut Sheets

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FIRE PROTECTION  
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Section 210000  
FIRE PROTECTION

(Filed Sub-Bid Required)

**PART 1 - GENERAL**

1.1 FILING SUB-BIDS

- A. Sub-bids for Work under this Section shall be for the complete Work required hereunder and shall be filed in a sealed envelope with the Awarding Authority before the time and date and at the location indicated in the Instructions to Bidders and at that time will be publicly opened and read aloud.
- B. Procedure for filing Sub-Bids shall be as set forth in the Instructions to Bidders contained in this Project Manual and shall conform to all requirements of the Commonwealth of Massachusetts General Laws, Chapter 149, as amended to date.
- C. Every Sub-Bid submitted for Work under this Section shall be on a form furnished by the Awarding Authority as required by Section 44G of Chapter 149, as amended, which form is required to be completely filled in. A sample bid form for Subcontractors is contained in this Project Manual and the bid form to be used in filing a Sub-Bid is available at the office of the Architect.
- D. Every Sub-Bid filed with the Awarding Authority shall be accompanied by bid security in the form and amount stipulated in the Instructions to Bidders.
- E. No sub-sub bids are required for this Section.

1.2 GENERAL PROVISIONS

- A. All the Contract Documents and General Provisions of the Contract including, but not limited to, General and Supplementary Conditions, and Division 1 Specification Sections apply to this Section.
- B. The work of this Section provides and contains general information which is inherently made a part of each Section and applies to all work performed under this Contract.

1.3 DESCRIPTION OF WORK

- A. Provide all labor, materials, equipment, services and accessories necessary to Design, Furnish and Install the work of this Section, complete and functional, as indicated in the Contract Documents and as specified herein. The Design shall conform to the documents and shall be subject to approval by the Architect.
- B. Without limiting the generality thereof, the work to be performed under this Section includes:
  - 1. Fire Service connecting to existing water main in Flagg Drive as shown on the drawings.

2. A hydraulically designed combination automatic sprinkler/standpipe system to provide 100% protection for the new and existing building as noted on the Drawings. Refer to Fire Protection Criteria on the Drawings. Prepare Working Drawings for approval of the Architect, the local authority having jurisdiction, and the owner's insurance company under stamp of an independent Massachusetts Registered Professional Fire Protection Engineer.
3. Hydrant flow test
4. Backflow Control Device
5. Fire Department Connections.
6. Pipe and Fittings
7. Valves
8. Hangers
9. Sprinkler Heads
10. Furnishing and installation of Supervisory Switches and Controls
11. Systems Identification
12. Flushing and Testing of the interior and exterior system as provided herein.
13. Drilling, Coring, Cutting & Patching of holes and openings (where the largest dimension thereof does not exceed 12 inches), for Fire Protection Piping and Equipment. All such holes require sleeves.
14. Scaffolding, Rigging, and Staging required for all Fire Protection Work. Comply with Division 1 requirements.
15. Provide Seismic Restraints for all Fire Protection Systems conforming to the requirements of Section 230548 which Section is herein incorporated by reference as work of the Fire Protection Sub Contractor. Seismic Restraints are required in both new and existing building.
16. Furnishing of Access Panels
17. Smoke and Firestopping Seals and sealing of all wall penetrations as detailed on the drawings. Refer to Section 078400 which defines the firestopping materials and methods.
18. When open-flame or spark producing tools such as blower torches, welding equipment, and the like are required in the process of executing the work, the General Contractor shall be notified not less than twenty four hours in advance of the time that the work is to begin and the location where work is to be performed. Provide fire protective covering and maintain constant non-working fire watch through the Local Fire Department where work is being performed and until it is completed.
19. It shall be the responsibility of this division 210000 to provide all personnel as required to fully coordinate with the commissioning agent. The hours of training and instruction outlined in this division 210000 and the Testing requirements shall be in addition to those tests and requirements outlined in section 019113 & 21 08 00 and required to fulfill section 019113 & 21 08 00 commissioning obligations.

#### 1.4 RELATED WORK

- A. The following items of work related to the Fire Protection Work are included under other Sections of the Specifications:
1. Cutting & Patching beyond 1.3B.13 above: SECTION 010450 - CUTTING AND PATCHING.
  2. Installation of Access Panels: Respective finish section.
  3. Excavation and Backfill: DIVISION 31
  4. Finish Painting: SECTION 099000: PAINTING
  5. Wiring for Supervisory Switches, Electrical Alarm, and Flow Switches, and Power Wiring: SECTION 260000 - ELECTRICAL
  6. Temporary Facilities: SECTION 015000 - TEMPORARY FACILITIES
  7. Installation of Hood Suppression System – SECTION 114000 FOOD SERVICE EQUIPMENT

#### 1.5 CODES, ORDINANCES, AND PERMITS

- A. Perform all work in accordance with the following Codes:
1. 780 CMR: The State Building Code.
  2. 527 CMR: The Fire Prevention Regulations.
  3. NFPA-13-2013, NFPA-14-2013, NFPA-24-2010, NFPA-241-2013, and Owner's insurance company requirements.
  4. All applicable Local, State, and Federal Codes, Statutes, or Regulations.
  5. City of Framingham Fire Department.
  6. City of Framingham Building Department.
- B. Obtain all permits, inspections, and approvals, from the governing authorities and pay all fees and include cost in the bid, including approvals for the cross connection control device. Provide the Owner with the cross connection permit for the device in the Owner's name.

#### 1.6 DISCREPANCIES IN DOCUMENTS

- A. Where Drawings or Specifications conflict or are unclear, advise Designer in writing before Award of Contract. Otherwise, Designer's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted due to discrepancies or unclarities thus resolved.
- B. Where Drawings or Specifications do not coincide with manufacturers' recommendations, or with applicable codes and standards, alert Designer in writing before installation. Otherwise, make changes in installed work as Designer requires within Contract Price.
- C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specs, this contractor shall provide that material, installation, or work which is of the higher standard.

- D. It is the intent of these contract documents to have the contractor provide systems and components that are fully complete and operational and fully suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component. In cases such as this, where the contractor has failed to notify the Designer of the situation in accordance with the paragraph above, the contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.
- E. In cases covered by the paragraph above, where the contractor believes he needs engineering guidance, he shall submit a sketch identifying his proposed solution and the Designer shall review, note if necessary, and approve the sketch.

#### 1.7 MODIFICATIONS IN LAYOUT

- A. HVAC, Plumbing, Fire Protection, and Electrical Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet architectural requirements.
- B. In all spaces, prior to installation of visible material and equipment, including access panels, review Architectural Drawings for exact locations and where not definitely indicated, request information from Designer.
- C. Check Contract Drawings as well as Shop Drawings of all subcontractors to verify and coordinate spaces in which work of this Section will be installed.
- D. Maintain maximum headroom at all locations. All piping and associated components to be as tight to underside of structure as possible.
- E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades and to coordinate according to Paragraphs A, B, C, D above. Systems shall be run in a rectilinear fashion.
- F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Designer for review and approval.

#### 1.8 RECORD DRAWINGS

- A. General: Refer to DIVISION 01 - GENERAL REQUIREMENTS for general requirements for maintaining as-built drawings and submitting final reproducible record documents.
- B. The General Contractor will provide two sets of black or blue line on white Drawings to the Fire Protection Subcontractor, one set of which shall be maintained at the site and which shall, at all times, be accurate, clear, and complete, showing the actual locations of all equipment and piping as it is being installed. The Record Drawings shall be available to the Architect/Engineer's field representative at all times.



- C. Provide electronic AutoCAD drawings to indicate revisions to piping size and location both exterior and interior; including locations of valves and other equipment requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column line; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located.
- D. Include in the Record Drawings any addenda, sketches, and supplementary Drawings issued during the course of construction.
- E. Non-availability of Record Drawings or inaccuracies therein will postpone the final inspection until they are available.
- F. All valves shown on these Drawings shall be numbered with numbers corresponding to those on the valve charts.
- G. All costs related to the foregoing requirements shall be paid by the Fire Protection Subcontractor.

#### 1.9 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Provide operating instructions to the owner's designated representative with respect to operation functions and maintenance procedures for all equipment and systems installed. At the completion of the project, turn over to the Architect four (4) complete manuals in three-ring, loose-leaf binders, containing the following:
  - 1. Complete Shop Drawings of all equipment.
  - 2. Operation description of all systems.
  - 3. Names, addresses, and telephone numbers of all suppliers of the system.
  - 4. Preventive maintenance instructions for all systems.
  - 5. Spare parts list of all system components.
  - 6. Valve tag chart noting location of any and all valves controlling the fire protection systems including main control, main drain, auxiliary drain, drum drip, inspectors test connections and any low point drains connected to these systems.
- B. Provide DVD recording of operation and maintenance training sessions and include as part of O & M Manual submittal. Training session video recording and DVDs shall be performed by a professional videographer. Provide indexed table of contents for DVD recording.

#### 1.10 SHOP DRAWINGS AND MATERIAL SCHEDULES

- A. Refer to SECTION 013300 - SUBMITTALS for substitution of equipment and submittal of Shop Drawings. If apparatus or materials are substituted for those specified, and such substitution necessitates changes in or additional connections, piping, supports or construction, same shall be provided as the responsibility, and at the expense, of the Fire Protection Subcontractor.

- B. Fabrication of any material or performing of any work prior to the final approval of the Submittals will be entirely at the risk of the Subcontractor. The Subcontractor is responsible for furnishing and installing materials called for in the Contract Documents, even though these materials may have been omitted from approved Submittals.
- C. Submit Shop Drawings for the following materials and equipment.
  - 1. Coordinated Working Drawings and hydraulic calculations including size, type, length, temperature rating of sprinkler heads, piping and the like. Indicate flow test results, design criteria, hydraulic reference points, diffuser and light locations.
  - 2. Access Panels and Covers
  - 3. Sprinkler Heads
  - 4. Hangers and Seismic Restraints
  - 5. Pipe, Fittings, and Appurtenances
  - 6. Systems Identification
  - 7. Valves
  - 8. Fire Department Connection
  - 9. Cross Connection Devices

#### 1.11 COORDINATION DRAWINGS

- A. Before materials are purchased or Work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces.
- B. Coordination Drawings are for the Contractor's and the Architect's use during Construction and shall not be construed as replacing any Shop or Record Drawings required elsewhere in these Contract Documents.
- C. Detailed procedures for Coordination Drawings are contained in DIVISION 01 of these Contract Documents.

#### 1.12 GUARANTEE

- A. Guarantee all work under this Section free from defects in workmanship or materials for a period of one (1) year from the date of final acceptance of the building, as set forth in the Contract.
- B. Replace any such defective work developing during this period, unless such defects are clearly the result of bad usage of equipment by others. Where such defective work results in damage to work of other Sections of the Specifications, restore such work to its original condition by mechanics skilled in the affected trade.

### 1.13 DRAWINGS

- A. All work shown on the Drawings is intended to be approximately correct to scale but shall be taken in a sense as diagrammatic. Sizes of pipes and general method of running them are shown, but it is not intended to show every offset and fitting. To carry out the true intent and purpose of the plans, furnish all necessary parts to make a complete working system ready for use.
- B. The Drawings and Specifications are intended to supplement each other so that any details shown on the Drawings and not mentioned in the Specifications, or vice-versa, shall be executed the same as if mentioned in the Specifications and shown on the Drawings.
- C. Refer to the Architectural, Structural, and Other Mechanical and Electrical Drawings which indicate the construction in which this work shall be installed. Locations shown on the plans shall be checked against the general and detailed drawings of the construction proper. All measurements must be taken at the building.

### 1.14 SYSTEM DESCRIPTION

- A. The building shall be 100% sprinklered with an automatic combination standpipe/sprinkler system. The system shall be designed in accordance with NFPA-13-2013 and NFPA 14-2013.
- B. Building is to be 100% sprinklered including all closets regardless of size, all Electric rooms, and all Emergency Electrical Rooms. The elevator shaft and elevator machine rooms are not sprinklered.
- C. Refer to Fire Protection Criteria on the Drawings. Conform to the zoning shown on the plans.
- D. Locations of sprinkler heads are shown in some of the areas to be sprinklered only to establish the patterns and design intent. Major equipment and runs of piping may also be shown. Refer to reflected ceiling plan for location of all sprinkler heads. All sprinkler heads are to be installed dead center of tile.
- E. The documents require that the building be covered 100%. This includes all closets, combustible concealed spaces, and other areas as required under NFPA-13-2013. These areas are to be included in the Sub-contractor's bid whether or not the heads are shown on the sprinkler plans.

### 1.15 ALARM FACILITIES

- A. Furnish and install all Supervisory Switches, Flow Switches, Pressure Switches, and other Alarm Devices. Install all such devices on the piping and coordinate with the Electrical Subcontractor who shall wire all such devices to the Fire Alarm System. Every shutoff valve installed on this project shall have a supervisory trouble switch wired to the Fire Alarm Panel.

1.16 PIPE MARKER IDENTIFICATION SYSTEM

- A. Mark all piping installed under this Section with a marking system in basic colors conforming to those specified in ANSI/ASME A-13.1. Markings shall indicate pipe content and direction of flow. Apply markers every 20 feet on center on piping which is exposed in mechanical or storage areas and above suspended accessible ceilings. Also, apply at all access panels, valves, tee joints, alarms, and/or controls.
- B. Adhesive system may be used throughout except at the mechanical rooms in which case markings shall be painted on.

1.17 VALVE TAGS

- A. All valves installed in the Fire Protection Contract shall be tagged. Tags shall be secured to valves with chain link and shall be marked with 3/4 inch high letters as to function. All valve tags shall indicate the Fire Zone.
- B. A corresponding framed Valve Tag Chart shall be installed within each Sprinkler Riser or Control Valve Room indicating location of each valve and the section it serves. This chart shall also be included within the Owner's O&M Manual with valve tag locations noted on the As-Built Sprinkler drawings.

1.18 IDENTIFICATION SIGNS

- A. All equipment and systems shall be identified with signs furnished and attached in accordance with NFPA 13.

1.19 PAINTING

- A. All interior exposed piping is to be painted and all painting, except as noted, will be done by the Painting Subcontractor. All uncovered piping and hangers shall be thoroughly cleaned of rust, oil, and other containments by the Fire Protection Subcontractor and left ready to receive primer coat.
- B. Painting for pipe markings shall be done under this Section.

1.20 WATER SUPPLY TEST DATA

- A. The following water supply data is included as information available to bidders.
- B. A hydrant flow test was performed on October 31, 2018, by Fire Protection Services at 31 Flagg Drive, Framingham, MA. Flow hydrant was located to the northwest corner of the existing Fuller Middle School. Gage hydrant was located on Flagg Drive, across from the existing Fuller Middle School.
- C. Flow Test Results:
  - 1. Static Pressure = 87 PSI
  - 2. Residual Pressure = 78 PSI
  - 3. Flow = 1,048 GPM

4. Estimated Flow at 20 PSI = 3,098 GPM

1.21 HOISTING EQUIPMENT AND MACHINERY

- A. Unless otherwise specified, all hoisting and rigging equipment and machinery required for the proper and expeditious prosecution and progress of the Work of this Section shall be furnished, installed, operated and maintained in safe condition by each sub-contractor, as specified under Section 015000, TEMPORARY FACILITIES AND CONTROLS.

1.22 STAGING AND SCAFFOLDING

- A. Unless otherwise specified, each sub-contractor shall provide all lifts and man-lifts, and furnish, erect and maintain in safe condition, all staging and scaffolding as specified under Section 015000 Temporary Facilities and Controls, as needed for proper execution of the work of this Section. Staging and scaffolding shall be of adequate design, erected and removed by experienced stage builders having all accident prevention devices required by Federal, state and local laws.

1.23 COMMISSIONING

- A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 019113 – General Commissioning Requirements and Section 21 08 00 Commissioning of Fire Protection Systems.
- B. Complete installation and startup checks and functional tests according to Section 019113 – General Commissioning Requirements and manufacturers written instructions and Section 21 08 00 Commissioning of Fire Protection Systems.
- C. Operational Test: After plumbing systems have been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the startup procedure.
- D. Verify that equipment is installed and commissioned as per requirements of Section 019113 & 23 08 00 and manufacturers written instructions/requirements.

1.24 BREAKDOWN

- A. Submit a breakdown of the contract price to aid the Architect in determining the value of the work installed as the job progresses.
- B. No requisition will be approved until the breakdown is delivered to the Architect.

1.25 VISIT TO SITE

- A. Prior to submitting a bid, visit the site of work and become familiar with existing conditions at the site of the work. Any assumptions made are at this Subcontractor's expense.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All materials and equipment furnished under this Section shall be new, unused, first quality of a manufacturer of established reputation and shall be U.L./F.M. approved. Each valve, fitting, section of pipe, and piece of equipment shall have cast or indelibly stamped thereon the manufacturer's name and pressure rating where applicable. All threads for fire department connection shall conform to the standards of the Local Fire Department.

### 2.2 PIPE AND FITTINGS

- A. Pipe and fittings shall conform to the latest A.S.A., A.S.T.M., C.A., and F.S. Standards. All grooved products shall be of one manufacturer to conform to NFPA Standards.
- B. All piping installed under this Section shall be in accordance with the following:
- | <u>Service</u>   | <u>Materials</u>                                   |
|--|--|
| Trim piping around alarm valves, sprinkler piping 1-1/2 inch and smaller | ASTM A-53, Schedule 40 black steel pipe            |
| Sprinkler and standpipe piping 2 inch and larger                         | Schedule 10, ASTM A-135 U.L./F.M. black steel pipe |
| Dry sprinkler system, regardless of size                                 | ASTM A-53, Schedule 40 galvanized steel pipe       |
| Underground service  | CL 52 ductile iron pipe                            |
- C. Fittings on fire line piping, 2 inch and larger, shall be Victaulic Fire Lock Ductile Iron Fittings conforming to ASTM A-536 with integral grooved shoulder and back stop lugs and grooved ends for use with Style 009-EZ or Style 005 couplings.
- D. Fittings for standpipes and risers, 2-1/2 inch and larger, and where ever required to conform to Seismic Requirements shall be Victaulic Vic-Flex Style 75 or 77 with Fire Lock Gasket.
- E. Branch line fittings shall be welded or shall be Victaulic 920/920N Mechanical Tees.
- F. Schedule 10 pipe shall be roll grooved. Schedule 40 pipe where used with mechanical couplings shall be rolled groove and shall be threaded where used with screwed fittings.
- G. Fittings for threaded piping shall be malleable iron screwed sprinkler fittings.
- H. All pipe and fittings shall be U.L./F.M. approved for sprinkler and standpipe service. All pipe and fittings shall be galvanized for dry system and black for wet system.

- I. Fittings on underground fire service piping shall be 250 psi gray iron fittings with mechanical joint ends. Coordinate with site contractor to assure all joints are properly thrust blocked.
- J. Grooved fittings shall be manufactured by Victaulic, Grinnell, Anvil, or equal.

### 2.3 JOINTS

- A. Threaded pipe joints shall have an approved thread compound applied on male threads only. Teflon tape shall be used for threads on sprinkler heads.
- B. Joints on piping, 2 inch and larger, shall be made up with Victaulic, or equal, Fire Lock Style 005, rigid coupling of ductile iron and pressure responsive gasket system for wet or dry sprinkler system as recommended by manufacturer. Couplings on dry systems shall be galvanized. Cutting, roll grooving, lubrication, and assembly of all joints shall be made strictly in accordance with manufacturer's recommendations. Exercise particular caution in the use of lubricant to avoid "squeeze out" of lubricant when system is in service.
- C. Grooved joints and fittings shall be manufactured by Victaulic, Grinnell, Anvil, or equal.
- D. Furnish and install where piping crosses building expansion joints a listed expansion joint. Expansion joints shall be Metraflex "Fireloop", or manufactured by Flexonic Company or Hyspan, or equal. Expansion joints shall be UL approved for use for fire sprinkler systems.
- E. All joints on Fire Service under slab shall be restrained up to the service stub flange connection above slab.

### 2.4 VALVES

- A. All shutoff and control valves shall be U.L./F.M. approved, indicating type valves equipped with a supervised trouble switch wired to the fire alarm system. Shutoffs and zone valves may be either OS&Y indicating gates or butterfly valves.
- B. Gate valves shall be outside screw and yoke indicating type, 175 psi W.P. and U.L./F.M. listed, Jenkins or equal. All such valves shall have supervised trouble switch.
- C. Butterfly valves shall be Victaulic Series 705-W for 2-1/2 inch and larger, and Milwaukee indicating type U.L./F.M. butterfly for threaded service. Coordinate with Electrical Sub-contractor to have factory installed monitor switches compatible with the remainder of the Fire Alarm System.
- D. Check valves shall be iron body bronze mounted U.L./F.M., 175# W.P. or U.L./F.M. wafer checks. Grooved end valves shall be Victaulic Style 717 Fire Lock Check Valve.
- E. Pressure relief valves shall be located on wet systems pressure regulating valves and downstream of check valves per NFPA-13-2013. Pressure relieve valves shall be listed and not less than 1/2 in. in size and shall be by AGF, Watts, Cla-Val or equal.

- F. Ball drips shall be Potter Roemer #5682, 3/4 inch straight design ball drip valve, or by Victaulic, Viking, or equal.
- G. Drains shall be provided in the systems as may be required by field conditions. Provide drains at all low points and wherever necessary to insure that all portions of the sprinkler piping may be completely drained. Test connections shall be provided as required to test all portions of the system. Pipe low point drains and test connections to suitable receptor as determined in field or shown on Drawings.
- H. Install an inspector's test connection at the furthest point of each sprinkler zone. Run discharge back to a suitable receptor. Exterior wall penetration is permitted with test drain but only as approved by the Architect.
- I. Valves shall be manufactured by Victaulic, Nibco, Viking, or equal. Inspector's test stations shall be manufactured by AFG, Tyco, Victaulic, or equal.

## 2.5 SPRINKLERS

- A. All sprinklers to be used on this project shall be Quick Response type and shall be stamped with date of manufacture and temperature rating. Temperature ratings shall be determined by the location of the heads per NFPA 13-2013, section 8.3.2.5, and shall be minimum 155 degrees F. throughout except in special areas around heat producing equipment, skylights, and attics in which case use temperature rating to conform with hazard as specified in NFPA 13-2013. Orifice diameter and K factor shall be appropriate to meet the hydraulic design criteria, the available water supply, and NFPA Standards.
- B. Furnish spare heads of each type installed located in a cabinet along with special sprinkler wrenches. The number of spares and location of cabinet shall be in complete accord with NFPA 13-2013.
- C. Sprinklers shall be manufactured by Tyco, Victaulic, Viking, or equal.
- D. Upright sprinkler heads in areas with no ceilings shall be Tyco Model "TY-FRB" Quick Response, upright natural brass finish heads. Include heavy duty sprinkler guards in all mechanical rooms, storage rooms, gymnasium, and general shop/maker spaces.
- E. Sidewall heads shall be Tyco Model "TY-FRB" Quick Response with white polyester head and escutcheon.
- F. Pendent wet sprinkler heads shall be Tyco Model "TY-FRB" Quick Response recessed adjustable escutcheon, white polyester finish.
- G. Concealed heads shall be Tyco Model "RFII" Quick Response concealed type, 1-1/2 inch adjustment white cover plate. In special areas, as may be noted on the Drawings, provide alternate cover plate finishes.
- H. Pendent dry sprinkler heads shall be Tyco Model "DS-1" Quick Response dry type, white polyester finish and escutcheon.
- I. Dry sidewall heads shall be Tyco Model "DS-1" dry horizontal sidewall heads, white polyester finish.



- J. Window sprinkler heads shall be Tyco Model "WS" pendent vertical sidewall heads, white polyester finish.
- K. Use of flexible stainless steel hose with fittings for fire protection service that connect sprinklers to branch lines in suspended ceilings is acceptable. Flexible hoses shall be UL/FM approved and shall comply with NFPA 13 standards. Hose assemblies shall be type 304 stainless steel with minimum 1-inch true-bore internal hose diameter. Ceiling bracket shall be galvanized steel and include multi-port style self-securing integrated snap-on clip ends that attach directly to the ceiling with tamper resistant screws.

## 2.6 FIRE DEPARTMENT CONNECTION

- A. Fire Department Inlet Connection shall be Croker #6350 Series; 4 inch Storz inlet x 4 inch outlet, 30 degree elbow, brass plate, and stamped "Sprinkler-Standpipe". Install 1/2" ball drip valve and chrome plated trim wall fitting on bottom of inlet fitting body. Provide access panel for servicing the ball drip.
- B. Fire Department Connection shall be manufactured by Croker, Potter Roemer, Elkhart, or equal.

## 2.7 FIRE STANDPIPE EQUIPMENT

- A. Fire Department Valves shall be Croker Series 5015 Fire Department Valves fitted with 2-1/2 inch x 1-1/2 inch reducer, caps and chains all conforming to Local Fire Department thread standard. Valves shall be polished chrome plated and shall be mounted in a recessed cabinet as indicated on Drawings.
- B. Cabinets for the Fire Department Valves shall be Croker model 1710 - 18 inch x 18 inch x 10 inch deep. cabinet, fully recessed, solid door, prime painted steel. Include graphic and door catch.
- C. Provide 32 inch x 32 inch access panels at floor control locations or recessed cabinets as appropriate to the wall construction. Provide graphic.
- D. Cabinets and access panels provided at fire standpipe equipment shall be fitted with pull handles. Cylinder locks are not allowed.
- E. Cabinets and valves shall be manufactured by Croker, Potter Roemer, Elkhart, or equal.

## 2.8 ROOF MANIFOLD

- A. Fire Department roof manifold shall be Croker #6890, cast brass, two 2-1/2 inch valves with 1-1/2 inch reducers and caps.
- B. Roof Manifold shall be manufactured by Croker, Potter Roemer, Elkhart or equal.

## 2.9 SUPPLEMENTARY STEEL, CHANNEL, AND SUPPORTS

- A. Furnish and install All Supplementary Steel, Channels, and Supports required for the proper installation, mounting, and support of all equipment.

- B. Supplementary Steel and Channels shall be firmly connected to building construction in a manner approved by the Architect.
- C. The type and size of the Supporting Channels and Supplementary Steel shall be determined by the Fire Protection Subcontractor and shall be sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.
- D. All Supplementary Steel and Channel shall be installed in a neat and workmanlike manner parallel to the walls, floor, and ceiling construction. All turns shall be made with 90 degree fittings, as required to suit the construction and installation conditions.

#### 2.10 HANGERS AND SEISMIC RESTRAINTS

- A. Hangers shall be furnished, installed, and supported from the building structure in accordance with NFPA - 13, Section 230548 and Drawing VS-1.
- B. All piping shall be seismic restrained.

#### 2.11 ALARM DEVICES

- A. Flow switches shall be vane type water flow detectors with 0-90 Sec. Adjustable non-accumulative retard device and (2) single pole double throw contacts, Notifier Series WFD Potter, VSR.F or equal. At base of standpipe risers, flow switch shall be a non-water discharge, auto-test vane type water flow detector with 0-90 second adjustable non-accumulative retard device and (2) single pole double throw contacts, Potter VSR.AT or equal. The flow switch shall be paired with either a single gang box test switch, Potter ATC-1 for testing a single device or ATC-4 for testing up to four devices."
- B. Pressure switches shall be adjustable Potter Model PS10A or equal.
- C. High/Low pressure switches shall be adjustable Potter Model PS40A or equal.
- D. Supervisory switches on all O.S. & Y. gate valves shall be Notifier NGV complete with mounting bracket.
- E. The wet system alarm device shall be Reliable Model 'E' alarm valve with "E1" trimmings. Package to include electric bell.
- F. Dry valve shall be Reliable Model "A" or "B" as dictated by Hydraulic Calculations complete with Electric Trim Package.
- G. Refer to Drawings for additional devices. Co-ordinate, prior to ordering devices, with the Electrical Sub-Contractor to assure device compatibility with the Fire Alarm System.
- H. Alarm valves shall be as manufactured by Reliable, Victaulic, Tyco, or equal. Flow, pressure and supervisory switches shall be manufactured by Potter, Notifier, System Sensor, or equal.

2.12 DOUBLE CHECK VALVE ASSEMBLY

- A. Double check valve assembly shall be State approved, U.L./F.M. approved, with iron body bronze mounted construction complete with supervised OS & Y gate valves and test cocks. Furnish two spare sets of gaskets and repair kits.
- B. Double check valve assembly shall be of one of the following:
  - 1. Watts Series 757-OSY
  - 2. Wilkins 350A-OSY
  - 3. Conbraco Series 4S-100
  - 4. Or equal.
- C. In the name of the owner pay for, file for, and obtain required permits from D.E.P. and/or local authority whichever has jurisdiction prior to installation.

2.13 ACCESS DOORS

- A. Furnish Access Doors for access to all concealed control valves, drains, inspector's tests, supervisory devices, and to all other concealed parts of the system that require accessibility for the proper operation and maintenance of the system. These doors shall be installed under the appropriate Section of the Specifications for the surface upon which the panels are mounted.
- B. All Access Doors shall be located in a workmanlike manner in closets, storage rooms, and/or non-public areas, positioned so that the valve or part can be easily reached, and the size shall be sufficient for this purpose (minimum size 12 inch x 16 inch). When access doors are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.
- C. Access Doors shall be prime painted and be complete with cylinder lock and two keys as manufactured by Acudor, Inland Steel Products Company "Milcor", or Walsh-Hannon-Gladwin, Inc., "Way Lector". Type shall be as follows:

Acoustical Tile Ceiling	Acudor AT-5020
W.B. Surfaces	Acudor DW-5040
Masonry Construction	Acudor UF-5000
Fire Rated Construction	Acudor FB-5060
- D. Access Doors Shop Drawings shall be submitted to the Architect for approval.

2.14 POST INDICATOR VALVE

- A. Post indicator valves (PIV) shall be Mueller co. UL/FM model A-20806 adjustable type indicator post with supervisory control valve switch model #PCVS-2. Post indicator valve shall be left hand open.
- B. Post Indicator Valve shall be manufactured by Mueller, Clow, American Flow Control, or equal.

## 2.15 DUCTILE IRON PIPE

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi.
  - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile or gray iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi.
  - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 2. Gaskets: AWWA C111, rubber.
- C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, round-grooved ends.
  - 1. Grooved-End, Ductile-Iron Pipe Appurtenances: ASTM A47, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions matching pipe, 350 psi.
  - 2. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions, Include ferrous housing sections, gasket suitable for water, and bolts and nuts. Joints shall be Tyton.
  - 3. Gaskets: AWWA C111.
- D. Flanged Ductile Iron Pipe: AWWA C115/A21.11, with factory applied screwed long hub flanges.
  - 1. Flanges: ASME B16.1 250 psi pressure ratings, as necessary.
  - 2. Wall Sleeve Castings, size and types shown on the drawings, shall be hot dipped galvanized per ASTM A123.
- E. Cement Mortar Internal Lining: Cement mortar lining and bituminous seal coat as per AWWA C104.
- F. Exterior Pipe Coating: The exterior of pipe shall have the standard asphaltic coating.

## 2.16 EXTERIOR GATE VALVES

- A. All gate valves shall conform in design and manufacturing to the latest issue of AWWA Standard C500 "Resilient-Seated Gate Valves for Water Supply", rated at 150 psi working pressure with a minimum 300 psi pressure test
- B. All valves shall have a 2 inch operating nut, mechanical joint hubs (except for wet tapping sleeves).
- C. Coordinate direction of valves opening with the local Water Department.

## 2.17 TAPPING SLEEVES

- A. Tapping sleeves shall be iron bodied and have a maximum working pressure of 250 psig and certified to ANSI/NSF 61. Outlet flange dimensions and drilling shall comply with ANSI B16.1, class 125 and MSS SP-60.
- B. Couplings to be used in connecting two plain ends of cast, ductile iron, or PVC pipe shall be of cast or ductile iron with bolts and nuts complying with AWWA C111. Couplings shall be Dresser Style 38, Smith-Blair Style 441, Clow Type F12308, or approved equal.

## 2.18 DETECTABLE UNDERGROUND WARNING TAPE

- A. Detectable warning tape shall be installed 12" directly above all buried utilities. Detectable warning tape shall consist of a nominal 4.5 mil (0.0045") overall thickness and 6" wide, with a solid aluminum foil core. The imprinted warning message is "Buried, or Encased" to prevent rub-off, and is impervious to acids, alkalis and other destructive elements found in soil. The imprint is as such that it allows for total reflectivity. A tape must be visibly seen before it can be read. The tape shall meet the testing requirements of ASTM D-882, Method A.
- B. Legend/Color & Imprint:
  - 1. Tape shall read "CAUTION BURIED WATER LINE BELOW".
  - 2. Tape color coding shall be Blue.

## 2.19 FIRESTOP SYSTEMS

- A. General: Provide firestopping at all new fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 078400 - Firestopping, for all product requirements for maintaining integrity of fire-rated construction at penetrations.

## 2.20 SCAFFOLDS AND STAGING

- A. General: Trade Contractors shall obtain required permits for, and provide scaffolds, staging, and other similar raised platforms, required to access their Work as specified in Section 01 50 00 - Temporary Facilities and Controls and herein.
  - 1. Scaffolding and staging required for use by this Trade Contractor pursuant to requirements of Section 01 50 00 - Temporary Facilities and Controls shall be furnished, erected, maintained in a safe condition, and dismantled when no longer required, by this Trade Contract requiring such scaffolding.
  - 2. Each Trade Contractor is responsible to provide, maintain and remove at dismantling, all tarpaulins and similar protective measures necessary to cover scaffolding for inclement weather conditions other than those required to be provided, maintained and removed by the General Contractor pursuant to MGL (Refer to Section 01 50 00 - Temporary Facilities and Controls and as additionally required for dust control).
  - 3. General Contractor is responsible to provide enclosures required for temporary heat; refer to Section 01 50 00 - Temporary Facilities and Controls.
    - a. Furnishing portable ladders and mobile platforms of all required heights, which may be necessary to perform the work of this trade, are the responsibility of this Trade Contractor.

## 2.21 HOISTING MACHINERY AND EQUIPMENT

- A. All hoisting equipment, rigging equipment, crane services and lift machinery required for the work by this Trade Contractor shall be furnished, installed, operated and maintained in safe conditions by this Trade Contractor, as referenced under Section 01 50 00 - Temporary Facilities and Controls.

## PART 3 - EXECUTION

### 3.1 WORKMANSHIP AND INSTALLATION METHODS

- A. All work shall be installed in a first-class manner consistent with the best current trade practices. All materials shall be securely installed plumb and/or level, and all flush mounted equipment shall have front edge flush with finished wall surface.
- B. Protect all concealed heads. Coordinate and advise finishing trades so as to prevent painting of sprinkler heads or inadvertent filling with paint or jointing compound of required air spaces in the case of the concealed type sprinkler heads.
- C. Training:
  - 1. Train the Owner's maintenance personnel on troubleshooting procedures, and servicing and preventative maintenance schedules and procedures.
  - 2. Schedule training with Owner through the Architect with at least 7 days prior notice.

### 3.2 WORK COORDINATION AND JOB OPERATIONS

- A. The equipment shall not be installed in congested and possible problem areas without first coordinating the installation of same.
- B. Before materials are purchased or work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces.
- C. Coordination Drawings are for the Contractor's and the Architect's use during construction and shall not be construed as replacing any Shop or Record Drawings required elsewhere in these Contract Documents.
- D. Detailed procedures for Coordination Drawings are contained in DIVISION 01 - GENERAL REQUIREMENTS of these Contract Documents.
- E. Particular attention shall be directed to the coordination of piping and other equipment installed in the ceiling areas. Coordinate the elevations of all piping in hung ceiling areas to insure adequate space for the installation of recessed lighting fixtures before other mechanical equipment is installed.
- F. Furnish to the General Contractor, and all other Subcontractors, all information relative to the portion of the Fire Protection installation that will affect them, sufficiently in advance so that they may plan their work and installation accordingly.
- G. In case of failure to give proper information as indicated above, sufficiently in advance, pay for all back-charges for the modification, renovation, and relocation of any portion of the work already performed.
- H. Obtain from the other trades, all information relative to the Fire Protection Work to be executed in conjunction with the installation of their respective equipment.

### 3.3 CUTTING AND CORE DRILLING

- A. Perform all cutting and core drilling operations that are outlined in Part 1 of this SECTION. Throughout the performance of the cutting and coring work, ensure that the structural integrity of the walls, floors, overhead structure, and other structural components is maintained until permanent work is installed. Prior to any coring or cutting, verify all locations of same with the General Contractor. All cutting and coring is to be performed in accordance with approved Coordination Drawings.
- B. Cut all masonry and concrete with an approved diamond blade concrete saw in a neat straight direction, perpendicular to the plane of the wall or floor.
- C. Use a core drilling process which produces clean, sharp edges and the minimum hole size which will accommodate the size of pipe sleeve specified.

- D. Patch all holes up to the sizes indicated in this Section with material and methods as are specified in the Section of the Specifications for the finish trade involved. Holes which are improperly done due to poor materials or method, shall be patched to the satisfaction of the Architect by the finish trade and back-charged to this Subcontractor.

#### 3.4 CLEANING AND PROTECTION

- A. Protect all materials and equipment during shipment and installation and properly handle and store at the job site so as to prevent damage. Assume full responsibility for protection of work until its completion and final acceptance.
- B. Keep the premises reasonable clean at all times and remove rubbish caused by the Fire Protection work as directed by the Architect.
- C. Upon completion of this work, clean all sprinklers, and equipment and replace damaged parts. Failure to fulfill this obligation will result in back-charges for correction of the defective work by others.

#### 3.5 SLEEVES, INSERTS, AND ESCUTCHEONS

- A. All piping passing through slabs, floors, walls, and partitions shall be sleeved and all such sleeves shall be furnished and installed by the Fire Protection Subcontractor as detailed on the Drawings and herein specified. Fire Protection Contractor, shall do his core drilling as approved by the Architect and the cored opening shall have a sleeve caulked and leaded in place. Set sleeves in concrete floors and walls as soon as forms set and before concrete is poured.
- B. All pipes passing through floor, whether slab-on grade or above grade levels shall be sleeved with sleeve extending 1 inch above floor. This includes all piping in toilet room pipe space, stairwells, closets, and partitions. In mechanical penthouses, pipe sleeves shall extend 4 inches above floor.
- C. All sleeves shall be Schedule 40 galvanized steel pipe and shall be reamed. There shall be annular space between the sleeve and pipe per NFPA requirements. Sleeves on drywall, masonry, or concrete walls and partitions shall be flush with wall on both sides.
- D. The space between sleeve and pipe, in all cases, shall be filled with U.L./F.M. approved caulking compound. This includes pipes concealed in chases and/or partitions.
- E. Inserts, where required, shall be furnished and set by the Fire Protection Subcontractor and, where necessary, may be drilled or power driven and shall be sized such that the insert will not exceed a depth of penetration of 1 inch into concrete.
- F. Escutcheons: All exposed pipe, uncovered, passing through walls, or floors, or ceilings, shall be fitted with C.P. brass spun or split type escutcheons with approved clamping device for holding in position. Floor escutcheons shall be deep enough to fit over sleeves, fastened to pipe, and extend down to floor.



### 3.6 TESTING

- A. Flush the system and test all work in the presence of the Architect and/or Engineer and as required by NFPA and the Insurance Company. The flushing and testing procedures to be followed are specified herein. At the completion of the testing, submit fully executed copies of Contractor's Material and Test Certificate for both above ground and underground piping as contained in NFPA-13.
1. Water Supply:
    - a. Flushing: Underground/exterior service entrance shall be flushed at a minimum velocity of 10 fps in accordance with NFPA Standards 13, 14, and 24. The Fire Protection sub-contractor shall coordinate with the Water and Fire Departments prior to testing of the entire exterior system.
  2. Sprinkler System:
    - a. Hydrostatic Testing: The interior system shall be hydrostatically tested at 200 psi for 2 hours in accordance with NFPA 13 paragraph 25.2.1.
    - b. Operational Testing: Water flow switches and associated alarm systems shall be tested by water flow through the inspectors test assemblies in accordance with NFPA 13, 25.2.3.
    - c. Main Drain Test: A flow test shall be performed on the main drain valve and recorded on the Contractor's test certificate in conformance with NFPA 13, 25.2.3.4.
    - d. Backflow Preventor Flow Test: The double check valve assembly shall be flow tested in conformance with NFPA 13, 25.2.5. Provide piping and or valving arrangement to preform full flow testing of backflow device.
    - e. Dry system shall be trip tested and acceptance tested with recorded results submitted to the owner for their review and record in accordance with NFPA 13 and 25. All dry systems shall be completely drained with all water removed prior to being placed in permanent service.
    - f. Underground Piping: Underground piping shall be hydrostatically tested, flushed and chlorinated in accordance with NFPA 24, the Local DPW, and any other pertinent laws or governing standards. Flushing, Testing and chlorination reports shall be given to the owner for review and included in the O&M Manuals for the fire protection systems.
  3. Standpipe or Bulk Fire Main:
    - a. Flushing: The fire department connection piping shall be flushed at a minimum velocity of 10 fps in conformance with NFPA 13, and NFPA 14.
    - b. Hydrostatic Testing: All piping shall be pressure tested at 200 psi for 2 hours in conformance with NFPA 14.
    - c. Flow Tests: The system shall be flow tested at the hydraulically most remote hose connection in conformance with NFPA 14.
    - d. Valve and Supervisory Switch Test: All valves and tamper switches will be tested by opening and closing valves in conformance with NFPA 14.

3.7 FIRESTOP SYSTEMS:

- A. General: Install firestop systems at all new fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 078400 - Firestopping, for all installation requirements for maintaining integrity of fire-rated construction at penetrations.

3.8 SEISMIC RESTRAINTS

- A. The independent engineer responsible for design of seismic restraints shall visit the project upon completion of the work to certify the installation is consistent with the approved shop drawings. The certification shall be submitted to the Architect and must precede the closing in of ceilings.

3.9 SYSTEM SHUTDOWNS

- A. Coordinate shutdowns of existing systems with the Owner and submit a written request at least ten working days in advance. Minimize system shut downs as much as possible. Submit a list of all affected areas, the proposed work to be performed, and the expected length of the shut-down including time for retesting.
- B. Provide temporary services to maintain active system during extended shut-downs as required for demolition and construction phasing.

END OF SECTION

Section 21 08 00

COMMISSIONING OF FIRE SUPPRESSION

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This section includes commissioning process requirements for Fire Suppression systems, assemblies, and equipment.
- B. Related Sections:
  - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "General Commissioning Requirements" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's role.
- B. Refer to Division 01 Section "Submittals" for specific requirements. In addition, provide the following:
- C. Certificates of readiness
- D. Certificates of completion of installation, prestart, and startup activities.
- E. O&M manuals
- F. Test reports

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments

immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

**PART 2 - PRODUCTS**

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the contractor for the equipment being tested. For example, the fire protection contractor of Division 21 shall ultimately be responsible for all standard testing equipment for the plumbing system in Division 21.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

**PART 3 - EXECUTION**

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for applicable commissioned components, equipment, and systems.
- B. Red-lined Drawings: The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined

drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.

- C. Operation and Maintenance Data: Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the contractor.
- D. Demonstration and Training: Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior to the training session.

### 3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Perform tests that are specified in the Division 21.
- B. Attend construction phase coordination meetings.
- C. Participate in Fire Suppression systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- D. Provide information requested by the CxA for final commissioning documentation.
- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Fire Suppression system orientations and inspections, operation and maintenance manual submissions, training sessions, flushing and cleaning, equipment start-up, and task completion for owner. Distribute preliminary schedule to commissioning team members.
- G. Update schedule as required throughout the construction period.
- H. Assist the CxA in all verification and functional performance tests.
- I. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- J. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
- K. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
- L. Participate in, and schedule vendors and contractors to participate in the training sessions.

- 
- M. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
    - 1. Life Safety/Fire Suppression equipment including pumps, piping, and all other equipment furnished under this Division.
    - 2. Automatic sprinkler and standpipe systems.
    - 3. Fire stopping in fire rated construction, including caulking, gasketing and sealing of smoke barriers.
  
  - N. The equipment supplier shall document the performance of his equipment.
  
  - O. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
  
  - P. Equipment Suppliers
    - 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
    - 2. Assist in equipment testing per agreements with contractors.
    - 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
  
  - Q. Refer to Division 01 Section "General Commissioning Requirements" for additional contractor responsibilities.
- 3.3 CxA'S RESPONSIBILITIES
- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's Responsibilities.
- 3.4 TESTING PREPARATION
- A. Certify in writing to the CxA that Life Safety/Fire Suppression systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
  
  - B. Certify in writing to the CxA that Life Safety/Fire Suppression instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
  
  - C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
  
  - D. Inspect and verify the position of each device and interlock identified on checklists.
  
  - E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
  
  - F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

---

### 3.5 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Life Safety/Fire Protection testing shall include entire Fire Suppression installation. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions.
- D. The CxA along with the Fire Suppression contractor shall prepare detailed testing plans, procedures, and checklists for Fire Suppression systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Fire Suppression system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

### 3.6 FIRE SUPPRESSION SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 21 sections. Provide submittals, test data, inspector record, and certifications to the CxA.
- B. Fire Suppression Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of sprinkler distribution systems.
- C. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

<b><i>Fire Suppression Systems</i></b>
Fire suppression systems

- 3.7 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT
- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.
- 3.8 APPROVAL
- A. Refer to Division 01 Section "General Commissioning Requirements" for approval procedures.
- 3.9 DEFERRED TESTING
- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deferred testing.
- 3.10 OPERATION AND MAINTENANCE MANUALS
- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 Section "General Commissioning Requirements" for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.
- 3.11 TRAINING OF OWNER PERSONNEL
- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to training.

End of Section



Section 220000

PLUMBING

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Section 220000

PLUMBING

(Filed Sub-Bid Required)

**PART 1 - GENERAL**

1.1 FILING SUB-BIDS

- A. Sub-bids for Work under this Section shall be for the complete Work required hereunder and shall be filed in a sealed envelope with the Awarding Authority before the time and date and at the location indicated in the Instructions to Bidders and at that time will be publicly opened and read aloud.
- B. Procedure for filing Sub-Bids shall be as set forth in the Instructions to Bidders contained in this Project Manual and shall conform to all requirements of the Commonwealth of Massachusetts General Laws, Chapter 149, as amended to date.
- C. Every Sub-Bid submitted for Work under this Section shall be on a form furnished by the Awarding Authority as required by Section 44G of Chapter 149, as amended, which form is required to be completely filled in. A sample bid form for Subcontractors is contained in this Project Manual and the bid form to be used in filing a Sub-Bid is available at the office of the Architect.
- D. Every Sub-Bid filed with the Awarding Authority shall be accompanied by bid security in the form and amount stipulated in the Instructions to Bidders.
- E. The Filed Sub-Bidder for the work of this SECTION 220000 shall list, in Paragraph E, of the FORM FOR SUB-BID, the name of each person, firm, or corporation, whom he proposes to use to perform the following classes of work or part thereof, at the bid price therefore:

CLASS OF WORK	PARAGRAPH NUMBERS
Insulation	2.5

1.2 GENERAL PROVISIONS

- A. All the Contract Documents and General Provisions of the Contract including, but not limited to, General and Supplementary Conditions, and Division 1 Specification Sections apply to this Section.
- B. The work of this Section provides and contains general information which is inherently made a part of each Section and applies to all work performed under this Contract.

1.3 DESCRIPTION OF WORK

- A. Provide all labor, materials, equipment, services and accessories necessary to furnish and install the work of this Section, complete and functional, as indicated in the Contract Documents and as specified herein.

- B. The work covered by this Section of the Specifications includes the furnishing of all labor and materials and in performing all operations in connection with the installation of the Plumbing Work.
- C. Without limiting the generality thereof, the work to be performed under this Section includes:
  - 1. Domestic cold water system throughout the entire building connecting to each and every fixture and piece of equipment requiring domestic cold water. The cold water system shall extend and connect to the cold water main ten feet outside of the building.
  - 2. Sanitary waste and vent system throughout the entire building connecting to each and every fixture and piece of equipment requiring sanitary drainage. This system shall extend and connect to the sanitary main ten feet outside of the building.
  - 3. Storm water drainage system throughout the entire building connecting to each and every roof and areaway drain requiring storm drainage. This system shall extend and connect to the storm main ten feet outside of the building.
  - 4. Special Waste and Vent System (Acid Waste) including neutralizer and pH monitoring system to 10 ft. outside.
  - 5. Kitchen grease waste and vent system including exterior precast concrete grease trap, manholes, and cast iron piping within the exterior grease trap.
  - 6. Hot, and Hot Water Re-circulation System throughout the entire building connecting to each and every fixture and piece of equipment requiring domestic cold and hot water.
  - 7. Lab. Non-Potable Cold and Hot water.
  - 8. Electric heat tracing for Lab Non- Potable hot piping to maintain temperature
  - 9. Natural gas system throughout the building connecting to each and every outlet and appliance requiring natural gas. This system shall extend and connect to the house side of the meter provided by the Utility Company.
  - 10. Gas connection to emergency generator.
  - 11. Floor, Roof and Trench Drain and piping.
  - 12. Furnish and install domestic water heater air intake and exhaust breeching.
  - 13. Furnish and install boiler air intake and exhaust breeching.
  - 14. Insulation.
  - 15. Domestic Hot Water Heater.
  - 16. Science Classroom Emergency Gas Solenoid Valve
  - 17. Fixtures and Equipment
  - 18. Connection to Equipment Furnished by Others
  - 19. Flushing, Sterilization, and Tests
  - 20. Furnishing of Access Panels
  - 21. Drilling, Coring and Cutting & Patching of holes and openings where the largest dimension thereof does not exceed 12 inches for Plumbing Piping and Equipment.

22. Provide and maintain temporary water service as directed by General Contractor. General Contractor to pay for all water use.
  23. Scaffolding, Rigging, and Staging required for all Plumbing Work. Comply with Division 1 requirements.
  24. Provide Seismic Restraints for all Plumbing Systems conforming to the requirements of Section 230548 which Section is herein incorporated by reference. Seismic restraints are required on all new systems whether in new or existing building.
  25. Preparation of Co-ordination Drawings.
  26. Smoke and Firestopping Seals and sealing of all wall penetrations as detailed on the drawings. Refer to Section 078400 which defines the firestopping materials and methods.
  27. At Project close out the Plumbing Sub-Contractor shall provide the services of an outside firm who shall run an underground video camera, locating all drainage system lines including depth, preparing a video and identifying & correcting any problem areas. The Plumbing Sub-Contractor shall rod-out and power wash all underground drainage systems. Turn over 4 copies of the video and written report to the owner. Videos are required for the underground sanitary, storm, kitchen waste, garage waste, and special waste systems.
  28. It shall be the responsibility of this division 220000 to provide all personnel as required to fully coordinate with the commissioning agent. The hours of training and instruction outlined in this division 220000 and the Testing requirements shall be in addition to those tests and requirements outlined in section 019113 & Section 220800 and required to fulfill section 019113 & Section 220800 commissioning obligations.
  29. When open-flame or spark producing tools such as blower torches, welding equipment, and the like are required in the process of executing the work, the General Contractor shall be notified not less than twenty four hours in advance of the time that the work is to begin and the location where work is to be performed. Provide fire protective covering and maintain constant non-working fire watch, paying all fees, where work is being performed and until it is completed. Fee for fire watch shall be included in the bid.
- D. Sustainable Design Intent: Comply with project requirements measured and documented according to LEED V4. Project scores will be verified by a third party certifier.
1. Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.
  2. Recycled content – for products or materials that contain recycled content, fill out the Materials Submittal Cover Sheet. Show percentage of product that is post-consumer and/or post-industrial recycled content. Provide backup documentation as described in Section 018113. Show installed costs for each line item.

#### 1.4 RELATED WORK

- A. The following Related Work will be performed under the designated Sections:

1. Domestic Water Service to 10 ft. outside – DIVISION 33 – UTILITIES
2. Cutting and Patching beyond 1.3C.21 above: SECTION 010450 - CUTTING AND PATCHING
3. Installation Of Roof Drains, Flashing for vents through roof: SECTION 075100 - ROOFING & FLASHING
4. Electric Power Wiring: SECTION 260000 - ELECTRICAL
5. HVAC Equipment: SECTION 230000 - HVAC
6. Excavation and Backfill: DIVISION 31 - EARTHWORK
7. Sanitary Sewer and storm drains to 10 feet outside the foundation wall: DIVISION 33 - UTILITIES
8. Finish Painting: SECTION 099000 - PAINTING
9. Installation of Access Panels: SECTION describing material in which panel is installed.
10. Toilet Room Accessories: SECTION 108000 - TOILET ACCESSORIES
11. Temporary Facilities: SECTION 015000 - TEMPORARY FACILITIES
12. Food Service Equipment: SECTION 114000 FOOD SERVICE EQUIPMENT
13. Laboratory Casework and Sinks: SECTION 123450 LABORATORY EQUIPMENT

#### 1.5 CODES, ORDINANCES, AND PERMITS

- A. Perform all work in accordance with the requirements of the Town of Framingham Building Department, Massachusetts State Plumbing and Fuel Gas Codes, D.E.P., A.D.A., NFPA, The Architectural Barrier Code, and applicable State and Federal Laws. Give all requisite notices, file all requisite plans, and obtain all permits required to perform all Plumbing Work. Where the Contract Documents indicate more stringent requirements than the above Codes and Ordinances, the Contract Documents shall take precedence.
- B. Obtain all permits, inspections, and approvals, from the governing authorities and pay all fees and include cost in the bid, including approvals for the cross connection control device. Provide the Owner with the cross connection permit for the device in the Owner's name.
- C. Owner will pay all related Gas Utility Company back charges.

#### 1.6 DISCREPANCIES IN DOCUMENTS

- A. Where Drawings or Specifications conflict or are unclear, advise Designer in writing before Award of Contract. Otherwise, Designer's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted due to discrepancies or unclarities thus resolved.
- B. Where Drawings or Specifications do not coincide with manufacturers' recommendations, or with applicable codes and standards, alert Designer in writing before installation. Otherwise, make changes in installed work as Designer requires within Contract Price.

- C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specs, this contractor shall provide that material, installation, or work which is of the higher standard.
- D. It is the intent of these contract documents to have the contractor provide systems and components that are fully complete and operational and fully suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component. In cases such as this, where the contractor has failed to notify the Designer of the situation in accordance with the paragraph above, the contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.
- E. In cases covered by the paragraph above, where the contractor believes he needs engineering guidance, he shall submit a sketch identifying his proposed solution and the Designer shall review, note if necessary, and approve the sketch.

#### 1.7 MODIFICATIONS IN LAYOUT

- A. HVAC, Plumbing, Fire Protection, and Electrical Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet architectural requirements.
- B. In all spaces, prior to installation of visible material and equipment, including access panels, review Architectural Drawings for exact locations and where not definitely indicated, request information from Designer.
- C. Check Contract Drawings as well as Shop Drawings of all subcontractors to verify and coordinate spaces in which work of this Section will be installed.
- D. Maintain maximum headroom at all locations. All piping and associated components to be as tight to underside of structure as possible.
- E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades and to coordinate according to Paragraphs A, B, C, D above. Systems shall be run in a rectilinear fashion.
- F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Designer for review and approval.

#### 1.8 SHOP DRAWING AND MATERIAL SCHEDULES

- A. Refer to SECTION 013000 - SUBMITTALS for submittal of Shop Drawings. If apparatus or materials are substituted for those specified, and such substitution necessitates changes in or additional connections, piping, supports or construction, same shall be provided as the responsibility, and at the expense, of the Plumbing Subcontractor.
- B. Fabrication of any material or performing of any work prior to the final approval of the Submittals will be entirely at the risk of the Plumbing Subcontractor. The

Plumbing Subcontractor is responsible for furnishing and installing materials called for in the Contract Documents, even though these materials may have been omitted from approved Submittals.

- C. Submit Shop Drawings for the following materials and equipment.
  - 1. Valves, Piping, couplings and Fittings
  - 2. Fixtures, Drains and Equipment including Supports
  - 3. Backflow Preventers
  - 4. Access Panels and Covers
  - 5. Insulation
  - 6. Drains, and Hydro Mechanical Specialties
  - 7. Hose Bibs, Wall Hydrants
  - 8. Hangers, Anchors, Guides, and Supports including Seismic Restraints
  - 9. Cleanouts
  - 10. Piping Identification System
  - 11. Water Heating Equipment
  - 12. Acid Neutralizer tank and monitoring equipment
  - 13. Air Compressors
  - 14. Water heater and boiler air intake and exhaust breeching including coordinated working drawings of installation.
  - 15. Precast concrete tank for acid neutralizers separator and access manholes.

#### 1.9 COORDINATION DRAWINGS

- A. Before materials are purchased or Work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces (match lines).
- B. Coordination Drawings are for the Contractor's and the Architect's use during Construction and shall not be construed as replacing any Shop or Record Drawings required elsewhere in these Contract Documents.
- C. Detailed procedures for Coordination Drawings are contained in DIVISION 01 - GENERAL REQUIREMENTS of these Contract Documents.

#### 1.10 RECORD DRAWINGS

- A. General: Refer to DIVISION 01 - GENERAL REQUIREMENTS for general requirements for maintaining as-built drawings and submitting final reproducible record documents.
- B. The General Contractor will provide two sets of Drawings to the Plumbing Subcontractor, one set of which shall be maintained at the site and which shall, at all times, be accurate, clear, and complete, showing the actual locations of all



equipment and piping as it is being installed. The Record Drawings shall be available to the Architect/Engineer's field representative at all times.

- C. Provide electronic AutoCAD drawings to indicate revisions to piping size and location both exterior and interior; including locations of valves and other equipment requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column line; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located.
- D. Include in the Record Drawings any addenda, sketches, and supplementary Drawings issued during the course of construction.
- E. Non-availability of Record Drawings or inaccuracies therein will postpone the final inspection until they are available.
- F. All valves shown on these Drawings shall be numbered with numbers corresponding to those on the valve charts.
- G. All costs related to the foregoing requirements shall be paid by the Plumbing Subcontractor.

#### 1.11 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Provide operating instructions to the Owner's designated representative with respect to operation functions and maintenance procedures for all equipment and systems installed. At the completion of the project, turn over to the Architect four (4) complete manuals, in three-ring, loose-leaf binders, containing the following:
  - 1. Complete Shop Drawings of all equipment.
  - 2. Operation description for all systems.
  - 3. Names, addresses, and telephone numbers of all suppliers of the system.
  - 4. Preventative maintenance instructions for all systems.
  - 5. Spare parts lists of all system components.
  - 6. Four copies of video of below slab piping.
  - 7. Valve tag chart.
- B. Provide DVD recording of operation and maintenance training sessions and include as part of O & M Manual submittal. Training session video recording and DVDs shall be performed by a professional videographer. Provide indexed table of contents for DVD recording.

#### 1.12 GUARANTEE

- A. Refer to Division 1 of the Contract. Guarantee all work under this Section free from defects in workmanship and materials for a period of one (1) year from the date of final acceptance of the building, as set forth in the Contract. Replace any such defective work developing during this period, unless such defects are clearly the result of bad usage of equipment by others. Where such defective work

results in damage to work of other Sections of the Specifications, restore such work to its original condition by mechanics skilled in the affected trade.

#### 1.13 DRAWINGS

- A. All work shown on the Drawings is intended to be approximately correct to scale, but shall be taken in a sense as diagrammatic. Sizes of pipes and general method of running them are shown, but it is not intended to show every offset and fitting. To carry out the true intent and purpose of the plans, furnish all necessary parts to make complete working systems ready for use. The Plumbing Drawings are intended to show the main stacks and risers and may or may not necessarily show all runout piping particularly in lavatories and gang toilet areas. Contractor shall include all runout piping to all referenced scheduled fixtures and equipment appearing on the Plumbing Drawings.
- B. All floor drains installed on this project, including all kitchen floor drains and trough drains, shall be equipped with trap primers. The trap primer and piping is not shown on the drawings and shall be located in the field by the Contractor as dictated by field piping conditions.
- C. The Plumbing Drawings and Specifications are intended to supplement each other so that any details shown on the Drawings and not mentioned in the Specifications, or vice-versa, shall be executed the same as if mentioned in the Specifications and shown on the Drawings.
- D. Refer to the Architectural, Structural, and other Mechanical and Electrical Drawings, which indicate the construction in which this Work shall be installed. Locations shown on the plans shall be checked against the general and detailed Drawings of the construction proper. All measurements shall be taken at the Building.

#### 1.14 VALVE TAGS, NAMEPLATES, AND CHARTS

- A. All valves on pipes of every description shall have neat circular brass valve tags at least 1-1/2 in. in diameter attached with brass hook to each valve stem. Stamp on these valve tags, in letters as large as practical, the number of the valve and the service, such as "H.W., C.W., GAS", for hot water, cold water, and gas respectively. The numbers for each service shall be consecutive. Where valves are located above ACT ceilings, furnish and install valve finder ceiling tack, tack shall be minimum 7/8 in. diameter with 1/2 in. steel point, color as determined by Owner.
- B. All valves on tanks and pumps shall be numbered by 3 in. red metal discs with white numbers 2 in. high, secured to stem of valves by means of small solid link brass chain, to correspond to numbers indicated for valves on the Record Drawings and on two (2) printed detailed lists. These printed lists shall state the numbers and locations of each valve and the fixture or group of fixtures which it controls, and other necessary information such as requiring the opening or closing of another valve or valves when any one valve is to be opened and closed, and shall be prepared in form to meet approval of the Architect, and shall be framed under glass.

- C. Nameplates, catalog numbers, and rating identifications shall be securely attached to Electrical and Mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

#### 1.15 PIPE MARKER IDENTIFICATION SYSTEM

- A. Mark all piping installed under this Section and at all Access Panels with a marking system in basic colors conforming to those specified in ANSI/ASME A-13.1. Markings shall indicate pipe content and direction of flow. Markers shall be applied at all valves and tee joints, and on straight runs of pipe at every 20 ft.-0 in. on center.
- B. Markers shall be vinyl snap-around pipe type system. Adhesive markings are not acceptable.
- C. Clearly mark potable and non-potable water system with 4 inch wide colored bands, with arrow for direction of flow, every twenty-five (25) feet on center on all piping installed whether it is concealed or exposed and also on both sides of floor and/or wall penetrations. Mark potable water green and non-potable yellow. Within 6 in. of each band identify with letter "Potable C.W.", Non-Potable H.W." Color of letter shall match banding.

#### 1.16 SANITARY, WASTE, VENT, KITCHEN GREASE WASTE AND VENT, GARAGE WASTE AND VENT, AND STORM SYSTEMS

- A. Furnish and install complete Sanitary, Waste, Vent, Kitchen Grease Waste and Vent, and Storm Drainage Systems (all hereinafter called Drainage Systems) to convey wastes from all Soil and Waste Stacks, Fixtures, Equipment, Kitchen Fixtures, and Roof Drains as indicated and/or described in these Plans and Specifications. Urinal waste shall be 2 in. cast iron or sizes indicated on the drawings. Waste piping smaller than 3 in. shall not be used underground. The use of double "Y's" in the horizontal shall not be permitted. All piping shall be installed straight and true and located concealed within building construction.
- B. All horizontal Drainage Systems Piping within the building, 3 in. and smaller, shall be pitched at least 1/4 in. per ft. in the direction of flow. Drainage Piping 4 in. and larger shall be pitched at least 1/8 in. per ft. Make changes in direction of drainage lines with 45 wyes, long turn wyes, or sweep bends.
- C. Furnish and install all cleanouts indicated on the Drawings and/or where required in Drainage Pipes regardless of size so that the distance between cleanouts does not exceed 45 ft. o.c. Cleanouts shall be installed at the base of all risers and at each change of direction.
- D. Refer to drawings for termination points, which generally are connection to existing piping or to 10 feet outside the building.
- E. The kitchen Grease Waste System shall be a completely separate system beginning at the exterior grease interceptor through the kitchen and vented individually through the roof. Do not connect soil lines to the grease waste nor sanitary vents to the grease vent. Furnish and install the cast iron tees and associated piping within the grease trap including 5-foot length on the outlet. All the piping within the grease trap shall be made up with caulked and leaded joints.

Locate inlet and outlet tees below access manholes to allow for inspection and maintenance. Exterior grease trap and access manholes shall be provided by this Section, 220000.

- F. The Garage Drainage System shall be a complete separate system piped from the interceptor. Vent through the roof without interconnection to any other building Drainage System including sanitary waste and vent.

#### 1.17 SUBSOIL DRAINAGE SYSTEM

- A. Furnish and install a complete sub-soil drainage system where shown and as detailed on the Plumbing drawings and as herein specified. Excavation, fabric, stone, and backfill is furnished under Division 31.
- B. Run the piping straight and true & pitched evenly at the rate of 1/32 inches per foot. Wherever crossing sanitary drainage piping run solid (non-perforated) piping for the sub-drain for a distance of 10 feet to either side of the crossing.
- C. Furnish and install flush cleanouts same as specified for sanitary drainage cleanouts.
- D. Co-ordinate the location and elevation of the subsoil drainage system with the General Contractor.

#### 1.18 DOMESTIC WATER SYSTEMS (POTABLE & NON-POTABLE)

- A. Furnish, install, sterilize, and test in accordance with the documents and the Plumbing Code, complete potable and non-potable Domestic Cold, Hot, and Hot Water Recirculating Systems including all piping, valves, low point drains, shock absorbers, hangers, insulation, backflow preventers and water heating equipment. Clearly mark the systems as provided above. This work shall start as indicated on the Drawings.
- B. In general, piping shall pitch upward in the direction of flow with each branch and riser separately valved and with 1/2 in. hose end drain on the outlet side of the valve and at all low points in the system. Install shutoff valves for each battery of fixtures and other valves as necessary to isolate any part of each system.
- C. Install shock absorbers on hot and cold water piping to each fixture. Provide shock absorbers at all quick closing valves and as shown on the Drawings and/or specified.
- D. Install a 1/2 inch hose bibb in each toilet room provided with a floor drain. The hose bibb shall be installed under a lavatory.
- E. Install a 1/2 inch hose bibb in each mechanical room.
- F. Furnish and install a ball valve, balancing valve and check valve at each hot water recirculation line before it connects to another hot water recirculation line.
- G. At all faucets connecting to the non-potable system whether furnished hereunder or by other sections, provide a "water unsafe" sign.

#### 1.19 EMERGENCY TEMPERED WATER SUPPLY

- A. Furnish, Install, Sterilize and Test utilizing the same materials, methods, etc. as specified above in 1.18. A tempered water supply to service all emergency showers and eye wash units. This piping shall be hung and insulated the same as above. Piping shall start at the tempering valve. Furnish and install flow switch at each emergency fixture location. Wiring of flow switch shall be provided by Division 26.

#### 1.20 FUEL GAS SYSTEM

- A. Furnish and install a complete Natural Gas Supply System including pipe, fittings, valves, connections to all gas fired equipment requiring gas, and all accessories and incidentals as indicated or specified. Installation shall be made in accordance with the State Gas Code requirements. Piping shall be installed with an 8 in. long sediment leg at the base of all risers. All changes in direction shall be made with plugged tees for cleaning piping out.
- B. All horizontal Gas Piping shall be pitched not less than 1/4 in. in 15 ft. to prevent traps. Pitch piping to risers. Install an 8 in. long sediment leg at the base of all risers. All changes in direction shall be made with plugged tees for cleaning piping out. All horizontal branch outlet pipes shall be taken from the top or side of horizontal mains and not from the bottom. Install shutoff valves for each battery of equipment and other valves as necessary to isolate any part of each system.
- C. Arrange with the Local Gas Company for the installation of the gas meters, services, and gas pressure regulators. Refer to DIVISION 01 - GENERAL REQUIREMENTS for information regarding Utility Company Charges.
- D. Provide seismic restraints for all gas piping per requirements of the Mass. Building Code. Refer also to Section 230548.
- E. Plumbing Sub-Contractor shall furnish and install all gas vents for all knockdown regulators whether furnished by this Section, HVAC, or any other Section.
- F. Gas to the Emergency Generator shall be installed according to the following:
  - 1. A dedicated fuel line shall be installed for the Generator immediately downstream of the meter assembly.
  - 2. The fuel line for the Emergency Power Generator and the fuel line for the remaining appliances shall each have a separate shut off valve installed immediately downstream of the meter to enable each line to operate independently.
  - 3. The fuel line for the Emergency Power Generator shall be labeled at the shut off valve on each side of the wall it penetrates, floor, and every 10 ft. along its run with the following:

WARNING: Emergency Power Generator. Do not shut off without the approval of appropriate authorities.

#### 1.21 SPECIAL WASTE AND VENT SYSTEM

- A. Furnish and install a complete Special Waste and Vent System to convey waste from all laboratory fixtures and equipment as shown on the Drawings and/or

herein specified and in accordance with Code requirements. The system shall be a complete independent system, using corrosion resistant piping from a point 10 feet outside building, running through a neutralization system and terminating independently through the roof. Furnish and install Neutralizer and Ph monitor where shown.

- B. Piping shall be run as indicated on the Drawings, properly secured to the building structure with iron hangers. When any end circuit vent pipe from any fixture or line of fixtures is connected to a vent line serving other fixtures, the connection shall be sufficiently more above the floor on which the fixtures are located to prevent the use of the vent line as a waste (6 in. above flood rim of fixture).
- C. All changes in pipe sizes and direction on Special Waste lines shall be made with 'Y's and cleanouts, reducing fittings or recessed reducers. 'Y's and 45 degree fittings or 45 degree combination fittings shall be used wherever possible.
- D. All offsets shall be at an angle of not more than 45 degrees. All horizontal runs of 3 in. and smaller pipe shall have a pitch of 1/4 in. to the foot; 4 in. and larger pipe shall pitch at 1/8 in. to the foot.
- E. Sanitary long sweep bends shall be used for connections to branch lines for fixtures and TY's on vertical runs of pipe only. Long turn fittings shall be used wherever conditions permit. Furnish and install cleanouts at every change in direction of Special Waste lines and where indicated on the Drawings.
- F. All fixtures shall be separately trapped. All traps shall be vented unless otherwise indicated on the Drawings for fixtures in battery vent systems. Provide bow vents where island benches are not part of a battery system.

#### 1.22 EQUIPMENT FURNISHED BY OTHERS

- A. Miscellaneous items, including but not necessarily limited to the following, shall be furnished and set by others as specified in other SECTIONS of the Documents.
  - 1. Laboratory Equipment
  - 2. Laboratory Sinks
  - 3. Dishwashers
  - 4. Kitchen Equipment
  - 5. Home Economics Equipment
  - 6. Miscellaneous Sinks
  - 7. Waste and Gas Submeters
  - 8. Generators
  - 9. Refrigerators
- B. Verify the extent of the connection requirements from the General, Architectural, and Mechanical Plans and Specifications and be responsible for: Setting in place, all such sinks and furnishing and installing trim and roughing including, but not limited to, drains, vent, water, gas, air or other plumbing piping, traps, tailpiece, nipples, escutcheons, faucets, and stop valves for all items which above are not so supplied. The equipment sections specify sinks including faucets and tailpieces as well as countertop turrets for gas. Include for all sinks which are

installed in cabinet work a pair of 1/2 in. ball valve stops (same as specified under 2.04) and a rough bronze p-trap, special waste trap, or sediment trap as required.

- C. Include a "Bakelight" stamped adhesive marker at each faucet indicating "Water Unsafe" as called for in 1.16 above.
- D. The Plumbing Subcontractor shall be responsible in making final connections to all equipment furnished by others, to ascertain complete cross-connection prevention compliance, and to furnish and install vacuum breaker and backflow preventers which may be required to be Code compliant and are not so furnished with the equipment.
- E. All sinks are intended to be "Accessible" and all drain outlets on all sinks and lavatories where furnished by the Plumbing Subcontractor or the other SECTIONS shall have an off-set drain. Set all roughing tight to wall in all cases to comply with ADA Standards. Provide where required ADA insulation kits to prevent injury where a barrier is not included in the casework. Refer to Equipment Drawings.

#### 1.23 PAINTING

- A. All interior exposed piping is to be painted and all painting, except as noted, will be done by the Painting Subcontractor. All uncovered piping and hangers shall be thoroughly cleaned of rust, oil, and other containments by the Plumbing Subcontractor and left ready to receive primer coat.
- B. Painting for pipe markings shall be done under this Section.
- C. Painting of exterior gas piping at gas meter, generator, on roof, and at rooftop equipment, shall be done under this Section.

#### 1.24 HOISTING EQUIPMENT AND MACHINERY

- A. Unless otherwise specified, all hoisting and rigging equipment and machinery required for the proper and expeditious prosecution and progress of the Work of this Section shall be furnished, installed, operated and maintained in safe condition by each sub-contractor, as specified under Section 015000, TEMPORARY FACILITIES AND CONTROLS.

1.25 STAGING AND SCAFFOLDING

- A. Unless otherwise specified, each sub-contractor shall provide all lifts and man-lifts, and furnish, erect and maintain in safe condition, all staging and scaffolding as specified under Section 015000 Temporary Facilities and Controls, as needed for proper execution of the work of this Section. Staging and scaffolding shall be of adequate design, erected and removed by experienced stage builders having all accident prevention devices required by Federal, state and local laws.

1.26 COMMISSIONING

- A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 019113 – General Commissioning Requirements & Section – 22 08 00 Commissioning of Plumbing Systems.
- B. Complete installation and startup checks and functional tests according to Section 019113 – General Commissioning Requirements, Section – 22 08 00 Commissioning of Plumbing Systems and manufacturers written instructions.
- C. Operational Test: After plumbing systems have been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the startup procedure.
- D. Verify that equipment is installed and commissioned as per requirements of Section 019113, 22 08 00 and manufacturers written instructions/requirements.

1.27 BREAKDOWN

- A. Submit a breakdown of the contract price to aid the Architect in determining the value of the work installed as the job progresses.
- B. No requisition will be approved until the breakdown is delivered to the Architect.

1.28 VISIT TO SITE

- A. Prior to submitting a Bid, visit the site of work and become familiar with existing conditions. Any assumptions made are at Plumbing Subcontractor's expense.

1.29 ENERGY REBATE PROGRAM

- A. This project has been designed to incorporate equipment approved for energy rebate such as domestic water heaters. Provide actual equipment purchase price to owner to assist filling out forms for utility company rebates.

1.30 TRADE RESPONSIBILITY FOR INTERCONNECTIONS MATRIX

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring	Notes



Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring	Notes
Natural Gas Energy Sub-Meters	23 00 00	22 00 00	26 00 00 & 23 00 00 (ATC)	23 00 00 (ATC)	N/A	3
Domestic Water Sub-Meters	23 00 00	22 00 00	26 00 00 & 23 00 00 (ATC)	23 00 00 (ATC)	N/A	3
Boiler and Domestic Water heater Exhaust Breaching	22 00 00	22 00 00	N/A	N/A	N/A	
Kitchen Emergency Gas Valve	22 00 00	22 00 00	26 00 00	26 00 00	26 00 00	

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All materials and equipment furnished under this SECTION shall be new, unused, first quality of a manufacturer of established reputation. Each valve, fitting, section of pipe, and piece of equipment supplied to project shall have cast or indelibly stamped thereon the manufacturer's name, pressure rating where applicable, type, and any other specific information provided by manufacturer. Materials shall conform to Massachusetts Code as a minimum requirement and shall appear on the Massachusetts Approved Plumbing Products list.

### 2.2 PIPE AND FITTINGS

- A. Pipe and fittings shall conform to the latest A.S.A., A.S.T.M., C.A., and F.S. standards.
- B. All piping installed under this SECTION shall be in accordance with the following:

<u>Service</u>	<u>Material</u>
Underground Domestic Water Service	Class 52 cement lined ductile iron pipe
Underground Drainage and Vent piping	Service weight cast iron soil pipe-coated bearing collective trademark of the Cast Iron Soil Pipe Institute (CISPI)
Above ground Drainage and Vent, piping 2 in. and larger	No Hub cast iron soil pipe and fittings bearing collective trademark of the CISPI
Above ground drainage, and Vent piping 2 in. and smaller	Type 'L' hard tempered copper tubing
Trap primer piping from Primer to floor drain	Type 'K' soft rolled copper tubing with Swaged ends
Domestic water piping above ground (potable & non-potable)	Type 'L' hard tempered copper tubing
Indirect waste piping	Type 'L' hard tempered copper tubing coated with two (2) coats of white epoxy paint
Special Waste and Vent Piping above ground	Schedule 40 electric heat fused flame retardant polypropylene piping, fittings,

- |   |   |
|---|---|
| (not in plenums)                                    | & traps; "George Fischer Fuseal" or approved equal  |
| Special Waste & Vent Piping below ground            | Schedule 40 electric heat fused non-flame retardant polypropylene piping; fittings & traps, "George Fischer Fuseal", Orion, Zurn or equal           |
| Gas piping above ground<br>Gas piping below ground  | black steel pipe<br>ASTM A-53 Schedule 40 black steel pipe with fusion bonded epoxy coating Scotchkote 6233 or equal.                               |
| Gas piping exposed in kitchen and at cooking island | ASTM A-53 Schedule 40 steel but painted with two (2) coats of white epoxy paint   |
| Footing & Subsoil drainage pipe                     | Schedule 40 PVC non-pressure Pipe with perforations conforming to ASTM Standard D2729. Where crossing sanitary use 20 feet of non-perforated P.V.C. |
- C. Fittings for underground Drainage Piping shall be service weight bell and spigot pattern C.I. soil pipe fittings. Above ground shall be no hub C.I. soil pipe fittings, Massachusetts Standard.
- D. Fittings for sweat drainage piping shall be cast bronze or wrought copper of recessed drainage pattern.
- E. Fittings for Type 'L' hard tempered copper tubing for potable and non-potable water piping 2-1/2 inch in size and smaller shall be copper press fittings.
- Acceptable Manufacturers:
    - Viega North America,
    - Ridge Tool Co.
    - Victaulic
    - Or equal
  - Material:
    - ASTM B88 and ANSI/ASME B16.22. O-rings for copper press fittings shall be EPDM.
  - Installation of copper press fittings and installation are to be made in strict accordance with the manufacturers installation instructions. All tubing is to be reamed prior to the installation of the fitting. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

- F. Grooved joint piping systems for domestic water piping 3-inch and larger shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves, and specialties shall be the products of a single domestic manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by the manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
- G. Fittings for polypropylene acid-waste and acid vent (special waste system) shall be Schedule 40 polypropylene fittings with electrical resistance heat fusion joints as manufactured by George Fischer, Orion, Zurn, or equal. All underground pipe and fittings shall be bedded, jointed, backfilled with materials and methods outlined by the manufacturer's published instructions.
- H. Fittings for compressed air piping shall be threaded malleable iron air pattern fittings for screwed pipe.
- I. Fittings for gas piping 2-inch and smaller shall be threaded malleable iron gas pattern fittings for screwed pipe. All gas piping 2 ½ inch in size and larger shall be welded and shall utilize butt welded steel pipe fittings.
- J. Fittings for underground domestic water service shall be 250 psi gray iron cement lined fittings with mechanical joint ends.
- K. Fittings for subsoil drainage piping shall be drainage pattern schedule 40 P.V.C. fittings with solvent end socket fittings all conforming to Mass. Standards.

### 2.3 JOINTS

- A. Joints for underground cast iron bell and spigot soil pipe shall be made up with resilient gaskets. Above ground shall be made up of heavy duty – 4 band stainless steel clamps, and gaskets. Couplings shall be in compliance with CISPI 310 and shall bear the mark of NSF International. Couplings shall be Husky "SD 4000", Clamp - All HI-TORQ 125, Mission "HW", or equal.
- B. Copper water tubing and fittings shall be assembled with press or grooved fittings depending on pipe size.
- C. Copper waste and vent tubing with sweat fittings shall be assembled with lead free solder, Silverbrite, Oatey, Harris, or equal, and a non-corrosive flux recommended by the manufacturer.
- D. Joints between copper waste/vent tubing and cast iron shall be made with cast iron threaded fittings and copper thread by sweat fittings.

- E. Joints between copper tubing and ductile iron water pipe or at flanged joints to tanks shall be made with a combination iron and brass flange with composition gasket and iron bolts.
- F. Joints at water heaters or other tanks having threaded connections shall be made up with dielectric unions.
- G. Joints between floor or wall flanges and fixtures shall be made with one-piece special molded neoprene gaskets which shall be furnished by the fixture manufacturer.
- H. Threaded pipe joints including plastics shall be made up with teflon tape.
- I. Joints on screwed gas piping shall be made up with thread compound on male threads only. Welded joints shall be made up by certified welders. All joints on piping 2-1/2 in. and larger, and on emergency generator exhaust regardless of size shall be welded.
- J. Joints on polypropylene acid waste and vent up to the outlet side of all traps shall be made up with electrical resistance fused joints utilizing manufacturer supplied power unit. Slip joints shall be used only in the final makeup connection between the trap and sink tailpiece. Vertical risers shall have vertical expansion joints at 20 ft. intervals. Horizontal runs shall have expansion joints in accordance with manufacturer's recommendations.
- K. Make up all joints on P.V.C. subsoil drainage pipe with solvent welding cement and cleaner made up in accordance with manufacturer's detailed instructions.

#### 2.4 VALVES

- A. Furnish and install valves where indicated on the Drawings or where specified and located so that they may be operated, repaired, or replaced with a minimum effort and repacked under pressure.
- B. The following list of valves is intended only as a guide for type and quality. Valves shall be as manufactured by Apollo, Milwaukee, Nibco, Elkhart, Watts or approved equal.

Shutoff valves	Apollo #94VLF-A lead-free ball valves
Balancing valves	Bell & Gossett Model CB lead free calibrated balance valve.
Gate valves 4 in. and larger	Jenkins 651-A
Stop and waste valves 1 in. and smaller	Apollo #95LF-203 through #95LF-205, lead-free
Check valves	Walworth #406 SJ
Gas service stops, 2 in. and smaller	Apollo #70-102-07 through #70-108-07 with tee handle

Gas service stops, 2-1/2 in. and larger	Rockwell #143 lubricated plug valve
Drain valves	Apollo #77WLF-HC ball valve with cap and chain 1/2 in. x 3/4 in. hose end
Compressed air line Shutoff valves	Apollo #70-100 Series-threaded ends
Compressed air outlet valves	Apollo #70-100 Series with automatic drain
Backwater Valve (Drainage Systems)	Zurn #Z1095. At below grade installations provide with extension to grade Zurn model Z1095-FC, height as required.

## 2.5 INSULATION

- A. Insulation for all water piping and all horizontal roof leaders whether concealed or exposed shall be 1 in. thick, heavy density, preformed snap-on insulation equal to Johns Manville Micro-Lok HP, 850 degrees snap-on system. Insulation for cold water piping shall have a factory applied vapor barrier with ends and butts sealed with overlapping 4 in. sealing strips.
- B. Valves, fittings, and the underside of roof drain bodies shall be insulated with pre-formed fiberglass fitting insulation cut from dense fiberglass blanket and covered with pre-molded P.V.C. fitting covers. P.V.C. covers shall overlap the adjoining insulation and shall be secured with pressure sensitive vinyl tape over a vapor barrier adhesive seal at the joints. (Note: Staples or tacks are not permitted on covers).
- C. All insulation shall have self-sealing type, all service jacket (ASJ-SSL) factory applied. At all exposed piping, cover jacket with continuous P.V.C. jacket.
- D. Sealers, solvents, tapes, and adhesives, and mastics used in conjunction with the installation of insulation under this Section shall possess the maximum possible fire safe qualities available and shall be NFPA approved.
- E. Covering shall be applied over clean and dry surfaces. No covering shall be applied until after the approval of all pressure and leakage tests.
- F. Insulation shall be as manufactured by Johns Manville, Inc., Owens-Corning Fiberglass Corporation SSL II-ASJ, or Knauf Insulation 1000. Insulation shall be applied by skilled insulation mechanics in a first class manner.

## 2.6 TRAPS

- A. Furnish and install traps with cleanouts on all fixtures and equipment requiring connection to the sanitary system of the same size and material as the pipe on which they occur. Traps installed on threaded pipe shall be recessed drainage pattern.

- B. Traps for the special waste system shall be Sloan polypropylene 'P' traps to suit installation. Traps shall be one-piece or shall utilize electric resistance connection. All traps shall be fitted with a cleanout plug.

## 2.7 DRAIN VALVES

- A. It shall be possible to drain the water from all sections of the Potable and Non-Potable Hot and Cold Water Piping. Furnish and install 1/2 in. x 3/4 in. hose end ball valves with cap and chain. (see 2.04 for model no.)

## 2.8 SHOCK ABSORBERS

- A. Furnish and install, where shown on Drawings and where required to prevent water hammer, Zurn Manufacturing Company model 1250-XL lead free shock absorbers, or equal, as manufactured by J.R. Smith Manufacturing Company, Josam Manufacturing Company, or equal.
- B. Installation of absorbers shall be as per manufacturer's recommendations.

## 2.9 PIPING ACCESSORIES

- A. Pressure and Temperature Relief Valves shall be A.S.M.E. rated temperature relief 210 deg. F. double BTU rated, self-closing, as manufactured by Watts Regulator Company or equal by Wilkins, McDonnell and Miller, or equal.
- B. Vacuum reliefs shall be lead free Watts Regulator Company #LFN36 or equal by Wilkins or Lawler.
- C. Temperature gauges shall be 4-1/2 in. diameter dial thermometers, any angle, and range of 30 degrees F. to 240 degrees F. as manufactured by Weiss Instruments, U.S. Gauge, Terice or equal.
- D. Potable and non-potable Water system pressure gauges shall be 4-1/2 in. diameter with a range of 0 to 160 psi as manufactured by Weiss Instruments, U.S. Gauge, Terice or equal.
- E. Natural gas system pressure gauges shall be 4 inch diameter with a range of 0 to 30 inches of water as manufactured by Weiss Instruments, U.S. Gauge, Terice or equal.
- F. Furnish and install where piping crosses building expansion joints on the domestic water piping and gas piping, expansion joints and anchors sized for 1-1/2 in. expansion per one hundred feet. Expansion joints shall be Metraflex "Metraloop", or manufactured by Flexonic Company or Hyspan, or equal. Piping shall be anchored and guided to force the expansion in the proper direction. Domestic water expansion joints shall be NSF approved. Gas expansion joints shall be AGA approved.
- G. Furnish and install where indicated on Drawings, Watts Regulator Company lead free pressure reducing valve and strainer combination size as indicated on the Drawing or equal, as manufactured by Donnelly Products Company or McDonnell and Miller.

- H. Trap primer connections are required on all floor drains to maintain trap seal. The requirement for trap primer connections shall include all floor drains in the kitchen including trough drains furnished by others. Trap primers shall be Precision Plumbing Products, Inc., Model PRO1-500 flow activated prime-pro trap-primer valve or shall, where appropriate, be Zurn, Josam, Smith or equal in-line connections installed on flush valve supply. Electronic trap primer shall be Precision Plumbing Products, Inc. Model MPB-500 mini-prime electronic trap-primer manifold, 120 volt, single phase. Furnish distribution units as required.
- I. At overflow storm drain leader termination points furnish and install vandal proof type 304 stainless steel downspout cover, Zurn model ZS-199-DC-VP, or as manufactured by JR Smith, Josam, or equal. All fasteners shall be stainless steel.

#### 2.10 HYDRANTS AND HOSE BIBB

- A. Wall hydrants shall be Zurn Series Z-1310-PB Ecolotrol cast brass 3/4 in. non-freeze wall hydrant with integral backflow preventer, 3/4 in. hose connections, polished nickel bronze face, loose key handle, brass wall sleeve, and fitted with brass locknut.
- B. Roof hydrants shall be Zurn Series Z-1388-RK exposed non-freeze roof hydrant with dura-coated cast iron head and lift handle with lock option, bronze interior parts, galvanized steel casing, and bronze valve housing with drain port. Complete with dura-coated cast iron roof support sleeve with anchoring flange and clamp collar. Contractor shall run drain to exterior. Coordinate drain location with Architect.
- C. Ground hydrants shall be Zurn Series Z-1360-HD-PB-VB, encased non-freeze hydrant, bronze casing, 3/4 inch hose connections, polished bronze face, loose key handle, and vacuum breaker.
- D. Hose bibb shall be T & S Brass or equal model #B-720 modified, chrome plated, 3/4 in. hose end, integral stop, vacuum breaker, modified with lock shield and loose tee handle.
- E. Hydrants shall be manufactured by Zurn, J.R. Smith, Josam, or equal. Hose bibbs shall be manufactured by T&S Brass, Speakman, Chicago, or equal.

#### 2.11 CLEANOUTS

- A. Cleanout plugs on the Sanitary System shall be of heavy cast brass of the screwed type. Plugs shall be full size up to and including 4 inch.
- B. For piping running under floor slab, cleanouts shall be brought up to just under the floor slab level. Furnish and install access cover for all floor-type cleanouts, Zurn ZN-1400 Series with scoriated nickel bronze or by Josam, J.R. Smith, or equal. In the garage area and at exterior locations use Zurn model #Z-1474 cleanout housing set over brass cleanout plug.
- C. Cleanouts for Special Waste System shall be as follows:
  - 1. On polypropylene pipe, use Zurn #Z9A-C04 polypropylene cleanout plug.



2. Below floor - Bring cleanout plug to below floor level and use Zurn #ZANB-1463-VP nickel bronze scoriated floor access cover mounted on Shamrock Industries concrete sleeve. See detail on drawings.

## 2.12 ACCESS DOORS

- A. Furnish Access Doors for access to all concealed control valves, cleanouts, valves, expansion joints, and to all other concealed parts of the Plumbing System that require accessibility for the proper operation and maintenance of the system. These doors shall be installed under the appropriate SECTION of the Specifications as determined by the surface upon which the panels are mounted.
- B. All Access Doors shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that the valve or part can be easily reached, and the size shall be sufficient for this purpose (minimum size 12 in. x 16 in.). Furnish Access Doors for each pipe space to permit thorough inspection of same. When access doors are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.
- C. Access doors shall be prime painted and completed with cylinder lock and two (2) keys as manufactured by Acudor, Inland Steel Products Company "Milcor", or Walsh-Hannon-Gladwin, Inc., "Way Lector". Type shall be as follows:
  1. Acoustical Tile Ceiling Acudor AT-5020
  2. G.W.B. Surfaces Acudor DW-5040
  3. Masonry Construction Acudor UF-5000
  4. Fire Rated Construction Acudor FB-5060
- D. Access Door Shop Drawings shall be submitted to the Architect for approval.

## 2.13 SUPPLEMENTARY STEEL, CHANNEL, AND SUPPORTS

- A. Furnish and install all supplementary steel, channels, and supports required for the proper installation, mounting, and support of all equipment.
- B. Supplementary Steel and Channels shall be firmly connected to building construction in a manner approved by the Architect.
- C. The type and size of the Supporting Channels and Supplementary Steel shall be determined by the Plumbing Subcontractor and shall be sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.
- D. All Supplementary Steel and Channel shall be installed in a neat and workmanlike manner parallel to the walls, floor, and ceiling construction. All turns shall be made with 90 deg. fittings, as necessary to suit the construction and installation conditions.

2.14 HANGERS, ANCHORS, GUIDES, AND PIERS

- A. All piping shall be supported from the Building Structure by means of approved hangers and supports. Piping shall be supported to maintain required grading and pitching of lines, to prevent vibration, and to secure piping in place, and shall be so arranged as to provide for expansion and contraction.
- B. The spacing for hangers for horizontal piping shall be in accordance with the following:
  - 1. Cast Iron Soil Pipe: 5 ft.-0 in. at the hubs for 5 ft. lengths. For 10 ft. lengths, use one (1) hanger at the hub and one (1) at midpoint of the length. Install cast iron pipe in accordance with CISPI Handbook - latest edition.
  - 2. Copper Tubing: 6 ft.-0 in. o.c. for 1-1/4 in. and smaller, and 10 ft.-0 in. o.c. for 1-1/2 in. and larger.
  - 3. Steel Pipe: 10 ft.-0 in. o.c. for 1-1/2 in. and over; 8 ft. - 0 in. for 1-1/4 in.; 6 ft. - 0 in. for 1 in. and smaller.
  - 4. Polypropylene acid waste: 4 ft.-0 in. o.c.
- C. Hanger rod diameter shall be as follows:

Pipe Size	Rod Diameter
1/2 in. thru 2 in.	3/8 in.
2-1/2 in. and 3 in.	1/2 in.
4 in. and 5 in.	5/8 in.
6 in.	3/4 in.
8 in. and over	7/8 in.

- D. Vertical lines shall be adequately supported at their bases by a suitable hanger placed in the horizontal line near the riser and at every 10 ft. interval.
- E. All Hangers (including those for acid-waste) shall be adjustable Clevis Hanger. Hanger rods shall have machine threads. Malleable iron brackets of approved type shall be used along the walls. All Hangers for copper tubing shall be copper plated except where pipe is insulated, in which case, Steel Clevis Hanger and pipe shield shall be used.
- F. Piping shall not be hung from the hangers of other trades.
- G. Provide seismic restraints for all piping per requirements of the MA Building Code and Section 230548. All gas piping shall be seismically restrained.
- H. Hangers shall be manufactured by Grinnell, Carpenter and Paterson, Fee and Mason, or equal.
- I. Wire and strap hangers will not be permitted in this installation.

- J. Install a 14 gauge metal pipe shield between pipe insulation and all pipe hangers. Hangers shall be sized so that the pipe insulation passes through the hanger and is supported on the shield.

## 2.15 DRAINS

- A. Furnish and install all floor drains and roof drains where shown on the Drawings.
- B. All floor drains in flooring systems without waterproofing membranes shall have galvanized iron clamping rings with 6-pound lead flashing to bond 9 in. in all directions. All drains shall be checked with Architect's Drawings to determine depth of the flashing collar. Brass extension pieces shall be provided if necessary.
- C. All floor drains installed on this project shall be fitted with Automatic Trap Primer Connections. Field determine appropriate location for Trap Primer valve and drain piping.
- D. Drain Schedule:
  1. Type "A" – Zurn #ZN-415-5BZ-P dura coated cast iron body with bottom outlet, combination invertible membrane clamp, adjustable collar, seepage slots, type BZ polished nickel bronze, light-duty, leveling strainer, trap primer connection.
  2. Type "B" – Zurn #Z-550-Y-P, 9 in. diameter top, dura coated cast iron body bottom outlet, seepage pan, combination membrane flashing clamp, frame for medium-duty, cast iron, heel-proof slotted grate, sediment bucket, cast iron grate, trap primer connection
  3. Type "C" - Zurn #ZC-100-DP-EA-G, galvanized cast iron body roof drain, under-deck clamp, galvanized cast iron dome secured, cast iron extension, roof sump receiver. Refer to Architect's Drawings for height of insulation.
  4. Type "D" - Zurn #ZN-1910-25-P cast iron body sanitary floor drain, white acid resisting interior and A.R.E. sediment bucket, 8 in. x 8 in. nickel-bronze frame and grate. Trap primer connection.
  5. Type "E" - Zurn #ZN-1901-25-2-P cast iron body sanitary floor drain, white acid resisting interior and A.R.E. sediment bucket, 6 in. Nickaloy Funnel. Trap primer connection.
  6. Type "F" - Zurn #ZN-1970-K-P-25, 12 in. x 12 in. x 8 in. deep A.R.E. cast iron floor drain with A.R.E. bucket and half grate.
  7. Type "G" – Zurn #ZN-1970-K-P-25, acid resistant cast iron body floor drain with trap primer connection, acid resisting sediment bucket, clamping collar, nickel bronze top, caulk bottom outlet, secured grate with vandal proof screws.
  8. Type "H" – Zurn #Z-556-G-Y galvanized cast iron, adjustable top, sediment bucket fitted with Z1099-G galvanized cast iron backwater valve.
  9. Type "I" - Zurn #Z-512-G-Y-VP Galvanized heavy duty cast iron body sediment bucket, heavy duty ductile iron secured grate, caulk bottom outlet.

10. Type "J" - Zurn #Z-103-C-E-G-GD-SS-45, galvanized cast iron body dual outlet roof drain, under-deck clamp, galvanized cast iron dome, cast iron extension, and stainless steel mesh screen over dome. Refer to Architect's Drawings for height of insulation.
11. Type "K" - Zurn #ZC163-E-G, galvanized cast iron body with combination roof drain and overflow, under-deck clamp, galvanized cast iron dome secured, cast iron extension, flashing clamp, gravel guard, double top set deck plate. Refer to Architect's Drawings for height of insulation.
12. Type "L" - Zurn #Z187-G-NH-VP, scupper drain, dura-coated galvanized cast iron body with reversible backer bottom bottom outlet (to match construction), flashing clamp.

- E. Drains shall be of one manufacturer, by Zurn, J.R. Smith, Josam, or equal.
- F. In bathrooms, coordinate all floor drain locations in field with Architect. Drain locations shall not conflict with toilet partition walls.

## 2.16 PLUMBING FIXTURES

- A. Furnish and install all fixtures and equipment, including supports, connections, fittings, and any incidentals, to make a complete installation in accordance with the Drawings and as specified.
- B. The Architect shall be final judge as to whether fixtures and trim fulfill the requirements of the Specifications and as to whether they are of suitable quality.
- C. All fixtures requiring hot and cold water shall have the cold water faucet on the right hand side of the fixture and the hot water faucet on the left hand side of the fixture.
- D. Escutcheons shall be furnished and installed on all supplies and traps. Escutcheons shall be one (1) piece chrome plated brass with set screws.
- E. All fixtures shall have the manufacturer's guaranteed label or trademark indicating first quality. All acid resisting enameled ware shall bear the manufacturer's symbol signifying acid resisting material.
- F. Unless otherwise specified, faucets and all exposed fittings shall be chromium plated.
- G. All supply pipes shall run in a reasonable straight vertical line from the stops to faucets. Traps shall be installed perpendicular to walls.
- H. Note: All fixtures and fittings shall be vandal proof mounted, unless specifically noted otherwise.
- I. Carefully coordinate roughing for flush valves so that the dimension from top of fixture to C-L of flush valve is a minimum of 6 in.
- J. In general, the work of this Article shall include, but not be limited to:
  1. Plumbing fixtures and trim.

2. Faucets and flushometers.
3. Stops and supplies.
4. Traps and tailpieces.
5. Drain outlets.
6. Mixing valves.
7. Shower assemblies.
8. Flow controls.
9. Carriers and supports.
10. Lavatory insulators.

K. Fixtures and Trim

1. Acceptable Manufacturers: Submit manufacturers not listed below for review and approval as specified for substitutions in this Section.
  - a. Vitreous China: Eljer, American Standard, Crane, Kohler or equal.
  - b. Molded Composite Lavatories: Bradley, Intersan or equal
  - c. Faucets: Chicago Faucet Co., Kohler or T & S Brass or equal.
  - d. Self Closing Faucets: Chicago Faucet Co., Sloan, Kohler, Symmons or equal.
  - e. Sensor Faucets: Chicago Faucet Co., Hydrotek, Sloan or equal.
  - f. Stainless Steel Sinks: Elkay, Just Manufacturing, Metcraft Inc or equal.
  - g. Mop Service Basins: Crane, Fiat , Stern Williams or equal.
  - h. Carriers and Supports: Jay R. Smith, Wade, or equal.
  - i. Thermostatic Mixing Valves: Leonard Valve Co., Powers Process Controls, Symmons, Chicago Faucets or equal.
  - j. Pressure Regulating Mixing Valves: Lawler Manufacturing, Leonard Valve Co Symmons or equal.
  - k. Shower Enclosure: Aquatic, Aquarius, Clarion or equal
  - l. Shower Head: Symmons, American Standard Kohler or equal
  - m. Water Fountain: Haws, Halsey Taylor, Filtrine or equal.
  - n. Trench Drains: MiFAB, Jay R Smith, Watts
  - o. Flush Valves: Sloan, American Standards, Hydrotek or equal.
  - p. Stops and Supplies: Chicago Faucet Co., Kohler or McGuire.
  - q. P-Traps: McGuire, Sanitary-Dash, or Jameco.
  - r. Handicap Lavatory Insulation: McGuire, TCI Products or Truebro.
2. Fixture Trim and Accessories: Provide fixtures complete with floor mounted fixture carrier supports; faucets, flushometers; drain outlets, tailpieces, P-traps and stops and supplies.
  - a. Color and Finish: All trim exposed to view shall be polished chrome plated, and all fixtures and toilet seats shall be white unless specified otherwise.
  - b. Drain Outlets: Provide drain outlet of the same manufacturer as the fixture or faucet trim with chrome plated 17 gauge minimum weight tailpiece.
    - 1) Provide 1-1/4 inch tailpiece on lavatories.

- 2) Provide 1-1/2 inch tailpiece on sinks.
- 3) Provide offset drain outlets on handicapped use lavatories and sinks.
3. P-Traps: Cast brass adjustable P-trap with cleanout plug, ground joint and 17 gage minimum weight extension with escutcheon.
  - a. Provide McGuire No. 8090 1-1/4 inch by 1-1/2 inch on lavatories.
  - b. Provide McGuire No. 8089 1-1/2 inch by 1-1/2 inch on sinks.
4. Stops and Supplies: Provide stops and supplies of the same manufacturer as the fixture or faucet trim, or provide McGuire Model 170-LK loose key angle stop with 5 inch long 2 inch nominal copper sweat extension, bell escutcheon, and 3/8 inch O.D. by 12 inch flexible riser.
5. Sinks: Seamlessly drawn, self-rimming minimum 18 gauge, type 302 (18-8) nickel bearing stainless steel with 1-3/4 inch minimum rounded corners, satin finish, and fully undercoated.
6. Faucets: Chrome plated cast brass with stainless steel seats and monel stems. Gooseneck spouts shall be interchangeable and convertible rigid/swing type. Handles shall be interchangeable with square handle broachings.
7. Flushometers: Diaphragm operated cast-brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, vacuum breaker. The flush valve shall be electric sensor operated with true manual override feature.
8. Water Conservation: Provide water conserving fixtures (water sense labeled) and trim in compliance with the following maximum water use requirements. Provide Omni or equal variable pressure flow controls on sinks, and lavatory faucets.
  - a. Public lavatories: 0.35 gpm
  - b. Sinks: 1.5 gpm
  - c. Water Closets: 1.28 gallons per flush.
  - d. Urinals: 0.125 gpf
9. Fixture Supports: Provide floor mounted fixture support carriers for wall mounted fixtures including but not limited to: water closets, lavatories, scrub sinks, urinals, and clinical sinks.
10. Fixture carriers shall support at least 250 pounds on the front rim of the fixture for 5 minutes.
  - a. Water Closets: Jay R. Smith Series 200-Y
  - b. Urinals: Jay R. Smith 637.
  - c. Lavatories: Jay R. Smith 700-M31.
  - d. Wheel Chair Lavatories: Jay R. Smith 700-27-M31.

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11. Toilet Seats: Provide extra heavy-duty, commercial/industrial type, elongated, open front, solid white injection molded plastic with integral bumpers; and self sustaining stainless steel check hinges.
    - a. Acceptable Manufacturers: Bemis, Beneke, or Church.
  12. Handicap Lavatory and Sink Insulation: Shall be provided on water supplies and waste piping below handicapped use lavatories and sinks.
    - a. Acceptable Manufacturers: McGuire, TCI Products or Truebro.
- B. Fixture Description
1. P-1 HET Water Closet, Equal to American Standard Model AFWall Millenium 2859. Vitreous china wall hung, white, elongated wall outlet water closet, 1.1 GPF, 1-1/2" top spud. Toilet flush valve to be water sense labeled, Manual 1.28 gpf flushometer. Equal to American Standard 6047.111.002. Provide combination drainage fitting and chair carrier to suit. Extra heavy duty solid plastic seat with check hinges (open front). Water closet shall be in compliance to the applicable section of ASME A112.19.2/ CSA B45.1
  2. P-1A Water Closet (Barrier Free) Same as P-1, except mounting in accordance with architectural barriers board.
  3. P-2 Urinal: Wall hung, 0.125 gpf vitreous china, top spud urinal equal to American Standard model Maybrook Universal 6581.00EC. The Flush valve to be water sense labeled, manual 0.125 gpf equal to American Standard 6045.013.002.
  4. P-2A Urinal (Barrier Free) Same as P-2, except mounting in accordance with architectural barriers board.
  5. P-3: American Standard undercounter Sink model Orbit 0630.0, ASME A112.19.2; vitreous china, unglazed rim for undercounter mounting, 15.5" round size with Bowl size 12"x4", Deck Mounted ,Single hole metering faucet, (lead free), Water Sense, 0.35 gpm aerator. Faucet (ADA) to be equal to Chicago Faucets Model 3500-4E39VPABCP. Provide Trim Plates, Chrome Plated brass grid strainer w/ 1 ¼ outlet tube. Mounting height in accordance with architectural elevation drawing. Provide point of use thermostatic mixing valve, Conceal all exposed roughing under lavatory with Truebro Lav Guard2 #103 E-Z insulation kit.
  6. P-3A : American Standard Murro Universal Design 0954.00 wall hung lavatory, ASME A112.19.2; vitreous china, wall hung wheel chair lavatory, 22" deep x 21.25" wide with 4" center faucet hole, Bowl size 15.5"x13.5"x 5", concealed arm brackets. Deck Mounted 4" fixed centers metering faucet, (lead free), 0.35 gpm aerator. Faucet to be equal to Chicago Faucets Model 3500-4E39PABCP. Provide Trim Plates, Chrome Plated brass grid strainer w/ 1 ¼ outlet tube. Mounting height in

- accordance with architectural elevation drawing. Provide knee guard insulation kit for trap and supplies.
7. P-4: Equal to Filtrine Model 107-16-HL-VP, vandal proof, wall mounted, high/low circular drinking fountain with vandal proof bubbler, security panel and bottle filler. Receptors shall be 16 in. diameter with 3/8 in. radius edges. Fountain, cover plate and bubbler to be 16 gauge steel with #4 Satin stainless steel finish. Low fountain location shall be on left. Include option for 1'-6" high access panel located below unit. Mount fountain per architect's direction. 1-1/4 in. x 1-1/2 in. rough p-trap with cleanout; 1/2 in. ball valve stop. Provide 3-spare filters.
  8. P-5 Floor Service Sink: Mop Receptor Fiat precast terrazzo mop basin, 24" x 24" x 12" with 6" drop front, stainless steel threshold, flange on wall sides. Fiat Model TSB-3010. Chicago 897 wall mounted service sink faucet w/ vacuum breaker spout. Wall hook, 24" long mop hanger with 3 spring clips. Provide 6' stainless steel braided water supply hose with pressure bleeder device and dual vented check valve (ASSE1055B approved) for secondary back flow preventer to soap dispenser connection. Installation shall be as per the plumbing code requirement.
  9. P-5A Wall Hung Utility Service Sink : Equal to American Standard Model # 7695.018, Enameled cast iron, 24" X 20-1/2" complete with rim guard, drilled back on 8" centers and #7798.176 P-trap, 3" outlet, floor support with strainer. Faucet shall be equal Chicago Model 956-RCP with #369 lever handle, 8" centers with vacuum breaker.
  10. P-6 Shower: Shower shall be equal to Praxis. Finished surface shall be of a sanitary grade polyester gelcoat, exhibiting a minimal thickness of 15 dry mills. The unit shall have outside dimensions of 36" x 36" x 72". The shower shall be equal to Symmons Temptrol Shower unit with hand spray model S-96-600-B30-L-V. Other approved manufacturers are Kohler, American Standard and Crane. Pressure balancing mixing valve, attached soap dish. Provide shower drain.
  11. P-6A Shower: Shower shall be equal to Praxis. Finished surface shall be of a sanitary grade polyester gelcoat, exhibiting a minimal thickness of 15 dry mills. The unit shall have outside dimensions of 36" x 60" x 72". Unit shall have a 3/4 in. threshold to meet MAAB requirements. Shower enclosure shall have fold-up cushioned seat and factory grab-bars to comply which MAAB requirements. The shower shall be equal to Symmons Temptrol Shower unit with hand spray model S-96-600-B30-L-V. Other approved manufacturers are Kohler, American Standard and Crane. Pressure balancing mixing valve, attached soap dish. Provide shower drain.
  12. P-7 SCIENCE CLASSROOM SINK:  
  
Elkay ELUH211510PD single bowl, 21 in. x 15 in. x 10 in. deep, under-counter mounted, 18 GA type 304 stainless steel sink with offset rear outlet; coordinate three (3) hole punching for sink with Architectural millwork, sound deadening underside.



Chicago No. 786-GN8BV-E7FC-CP-369 concealed deck faucet with 8 in. gooseneck spout, vacuum breaker, 2-3/8 in. wrist blade handles, E7FC 0.74 GPM aerator.

Elkay LKAD-35 crumb cup strainer with 1-1/2 in. offset tailpiece and stainless steel ground seat stopper. 1-1/2 in. x 2 in. chrome plated P-trap with cleanout, waste outlet with escutcheon. Pair of 1/2 in. x 3/8 in. supplies with stops and escutcheons.

13. P7A SCIENCE CLASSROOM SINK (BARRIER FREE):

Elkay ELUHAD211555PD single bowl, 21 in. x 15 in. x 5-1/2 in. deep, under-counter mounted, 18 GA type 304 stainless steel sink with offset rear outlet; coordinate three (3) hole punching for sink with Architectural millwork, sound deadening underside.

Chicago No. 786-GN8BV-E7FC-CP-369 concealed deck faucet with 8 in. gooseneck spout, vacuum breaker, 2-3/8 in. wrist blade handles, E7FC 0.74 GPM aerator.

Elkay LKAD-35 crumb cup strainer with 1-1/2 in. offset tailpiece and stainless steel ground seat stopper.

1-1/2 in. x 2 in. chrome plated P-trap with cleanout, waste outlet with escutcheon. Pair of 1/2 in. x 3/8 in. supplies with stops and escutcheons. Conceal all exposed roughing under sink with Truebro Lav Guard2 #103 E-Z insulation kit.

14. P-8 Classroom Sink with Bubbler Accessible

Elkay DRKR-ADA-1725, modified #18 ga. type 304 stainless steel, self-rimming, counter mounted sink modified with three (3) hole punching on right ledge, single hole on left ledge, 5-1/2 in. deep, centered rear drain opening, for 3-1/2 in. drain, ADA compliant, overall dimensions 17 in. x 25 in. x 5-1/2 in. deep bowl. Non abrasive sound deadening on underside.

Chicago #201A-GN8A-E2805-369 concealed deck faucet with 8 in. swing gooseneck spout, 2-3/8 inch wrist blade handles, E-2805 0.5 GPM aerator.

Chicago No. 748-665 self closing bubbler on left ledge. (Note Modification)

Elkay LKAD-35 crumb cup strainer with 1-1/2 in. offset tailpiece and stainless steel ground seat stopper. 1-1/2 in. x 2 in. chrome plated P-trap with cleanout, waste outlet with escutcheon. Pair of 1/2 in. ball valve stops and escutcheons.

Conceal all exposed roughing under sink with Truebro Lav Guard2 #103 E-Z insulation kit.

15. P-9 (Art Room)  
Elkay ELUH211510PD single bowl, 21 in. x 15 in. x 10 in. deep, under-counter mounted, 18 GA type 304 stainless steel sink with offset rear outlet; coordinate three (3) hole punching for sink with Architectural millwork, sound deadening underside.
- Chicago No. 201A-GN8A-E2805-5CP-317 concealed deck faucet with 8 in. swing gooseneck spout, 4 in. wrist blade handles, E-2805 0.5 GPM aerator.
- Elkay LKAD-35 crumb cup strainer with 1-1/2 in. offset tailpiece and stainless steel ground seat stopper.
- 1-1/2 in. x 2 in. chrome plated P-trap with cleanout, waste outlet with escutcheon. Pair of 1/2 in. x 3/8 in. supplies with stops and escutcheons. Zurn No. Z-1180 acid-resistant interior and exterior fabricated steel solids interceptor mounted on floor tight to wall. (Rough as tight to the wall as feasible). Provide point of use thermostatic mixing valve equal to Chicago Faucet model 131-CABNF
16. P-9A: (Art Room Sink-Barrier Free)  
Elkay ELUHAD211555PD single bowl, 21 in. x 15 in. x 5-1/2 in. deep, under-counter mounted, 18 GA type 304 stainless steel sink with offset rear outlet; coordinate three (3) hole punching for sink with Architectural millwork, sound deadening underside.
- Chicago No. 201A-GN8A-E2805-5CP-317 concealed deck faucet with 8 in. swing gooseneck spout, 4 in. wrist blade handles, E-2805 0.5 GPM aerator. Elkay LKAD-35 crumb cup strainer with 1-1/2 in. offset tailpiece and stainless steel ground seat stopper.
- 1-1/2 in. x 2 in. chrome plated P-trap with cleanout, waste outlet with escutcheon. Pair of 1/2 in. x 3/8 in. supplies with stops and escutcheons. Conceal all exposed roughing under sink with Truebro Lav Guard2 #103 E-Z insulation kit.
- Zurn No. Z-1180 acid-resistant interior and exterior fabricated steel solids interceptor mounted on floor tight to wall. (Rough as tight to the wall as feasible). Provide point of use thermostatic mixing valve equal to Chicago Faucet model 131-CABNF
21. P-10: Emergency Shower/Eyewash (Science Classrooms):  
Product shall be equal to Guardian GBF2152 emergency shower with ADA compliant swing activated eyewash system. Chrome plated shower head shall be mounted 96" above finish floor on 1" NPT chrome plated brass nipple. 1" NPTF chrome plated brass stay-open ball valve. Stainless steel triangular pull handle. Pull rod length shall be modified to accommodate varying ceiling heights. The integral eyewash shall be within stainless cabinet and activates automatically as the spray arms

are pulled downward. Provide flow switch to interface with BMS. See specification for thermostatic mixing valve.

22. P-11 : Fume Hood Service Connection  
Plumber shall provide cold water w/ vacuum breaker, gas, acid waste /trap and vent connection as per the manufacturer's instruction.
23. P-12 Valve Outlet Box
- a) P-12A Laundry Box: Laundry box (Metal) shall be fire rated equipped with hose bib outlet connections with hammer arrester, no lead valves and 2" drain connection. Laundry box shall be equal to IPS -FR-12. Other acceptable manufacturer Watts, Sioux or approved equal.
- d) P-12B Ice maker valve outlet: Furnish and install Fire Rated icemaker outlet Box with CSA listed, 1/2" quarter turn valve for pipe connection. The valve box shall be equal to model F-12 as manufactured by IPS Corp or approved equal.
24. P-13 Prep Sink with Eyewash:
- Elkay ELUHAD211555PD single bowl, 21 in. x 15 in. x 5-1/2 in. deep, under-counter mounted, 18 GA type 304 stainless steel sink with offset rear outlet; coordinate three (4) hole punching for sink with Architectural millwork countertop, sound deadening underside.
- Chicago #201A-GN8A-E2805-5CP-369 concealed deck faucet with 8 in. swing gooseneck spout, 2-3/8 inch wrist blade handles, E-2805 0.5 GPM aerator.
- Elkay LKAD-35-316 crumb cup strainer with 1-1/2 in. offset tailpiece and type 316 stainless steel ground seat stopper.
- 1-1/2 in. x 2 in. chrome plated P-trap with cleanout, waste outlet with escutcheon. Pair of 1/2 in. x 3/8 in. supplies with stops and escutcheons. Provide deck mounted eyewash, Guardian Equipment model G1893, 90 degree swivel, all stainless steel construction, corrosion resistant, right hand mounting. Unit shall include ANSI compliant sign. Furnish and install Guardian Equipment G3600LF emergency tempering valve. Valve shall be located below countertop against back wall.
25. P-14: Countertop Sinks (Fab Lab / Maker Space):
- Elkay ELUHAD211555PD single bowl, 21 in. x 15 in. x 5-1/2 in. deep, under-counter mounted, 18 GA type 304 stainless steel sink with offset rear outlet; coordinate three (3) hole punching for sink with Architectural millwork and countertop, sound deadening underside.
- Chicago No. 786-GN8BV-E7FC-CP-369 concealed deck faucet with 8 in. gooseneck spout, vacuum breaker, 2-3/8 in. wrist blade handles, E7FC 0.74 GPM aerator.

Elkay LKAD-35 crumb cup strainer with 1-1/2 in. offset tailpiece and stainless steel ground seat stopper.

1-1/2 in. x 2 in. chrome plated P-trap with cleanout, waste outlet with escutcheon. Pair of 1/2 in. x 3/8 in. supplies with stops and escutcheons. Conceal all exposed roughing under sink with Truebro Lav Guard2 #103 E-Z insulation kit. Provide point of use thermostatic mixing valve equal to Chicago Faucet model 131-CABNF.

26. P-15 Kitchenette Sink

Elkay DRKR-ADA-1725, modified #18 ga. type 304 stainless steel, self-rimming, counter mounted sink modified with three (3) hole punching on right ledge, single hole on left ledge, 5-1/2 in. deep, centered rear drain opening, for 3-1/2 in. drain, ADA compliant, overall dimensions 17 in. x 25 in. x 5-1/2 in. deep bowl. Non abrasive sound deadening on underside.

Chicago #201A-GN8A-E2805-369 concealed deck faucet with 8 in. swing gooseneck spout, 2-3/8 inch wrist blade handles, E-2805 0.5 GPM aerator.

Elkay LKAD-35 crumb cup strainer with 1-1/2 in. offset tailpiece and stainless steel ground seat stopper. 1-1/2 in. x 2 in. chrome plated P-trap with cleanout, waste outlet with escutcheon. Pair of 1/2 in. ball valve stops and escutcheons.  
Conceal all exposed roughing under sink with Truebro Lav Guard2 #103 E-Z insulation kit.

27. P-16 Gas Turret:

Chicago 980-VR909CAGSAM turret with single ball valve and check. Turret with anti-rotational deck pin, index button indicating gas, satin antimicrobial finish

28. P-17 Master Gas Control Valve:

Equal to ISIMET – LSP-T – Laboratory Service Panel with “T” handle providing manual operation of solenoid valve. Panel shall have brushed stainless steel door panel and trim with gray powder coated enclosure provided with low voltage transformer and fuse block. Enclosure shall be NEMA 1 rated. Panel shall be labeled “NATURAL GAS SERVICE PANEL”. Panel shall comply with UL508-A, Standards for Industrial Control Panels.

Panel shall have integral printed circuit board with logic device to provide 24-vac output circuit to activate integral 24-vac natural gas solenoid. Activation of output circuit shall be enabled only by switch ON and then keying.

The Panel shall be equipped with a service switch and a momentary enabling key switch. Deactivation of output circuit shall not require engagement of enabling key. Panel shall be provided with N/O momentary panic button assembly to deactivate output circuit in case of emergency. Reset after panic shall occur by re-keying. Green LED shall indicate operation ON. Red LED shall indicate that shut-down has occurred due to pressing the panic button.

Provide panel with additional terminals for integration of ISIMET Remote Panic Button Assembly and opto-isolated input terminal for integration with facility's alarm system. A fire alarm signal shall deactivate the utility controlled by the LSP Series Panel.

Provide panel with dry contact terminals for output integration. ISIMET "Panic" shall provide a notification signal to a secondary alarm monitoring system. Reset of Service Panel shall withdraw notification signal.

Service Panel shall be furnished with ISIMET Series 300 normally closed natural gas specific zero differential solenoid. Solenoid coil shall be 24-vac. Solenoid shall be UL listed. Service Panel shall be provided with a ball valve up-stream from solenoid. Thoroughly clean piping system prior to placing into service.

Do not install wiring or cable for integrated systems, remote panic assemblies or other interface wiring within conduit for either 24-vac control or 120-vac line voltage. Each wiring system should be housed in independent conduit and not bundled with wiring for other systems. Line and 24-vac control wiring furnished and installed by Electrical Subcontractor.

## 2.17 BACKFLOW PREVENTERS

- A. Backflow preventers shall be reduced pressure type furnished complete with shutoff valves, Massachusetts Approved. Backflow preventers 2-1/2 inch and smaller shall be Watts #LF009-QT-S. Backflow preventers 3 inch and larger shall be Watts 957-QT. Backflow preventers shall be lead free, all bronze, complete with strainer and soft seated check valve. Size shall be as indicated on Drawings.
- B. Mount backflow preventer 3 ft.(+/-) above finished floor. Provide indirect waste funnel and run pipe to an air gapped discharge at sink or floor drain. Furnish a spare parts kit and parts list mounted in the vicinity of the device.
- C. Prior to the installation of devices in the name of the Owner file for, pay for, and obtain all required permits and approvals for cross connection control devices from the Authority having Jurisdiction.
- D. Backflow preventers shall be of one manufacturer, by Watts, Wilkins, Beco, or equal.

## 2.18 UNION AND NIPPLES

- A. All connections between copper tubing and galvanized piping or between copper tubing and all tanks (such as water heaters, chillers, and similar equipment) shall be made with dielectric unions and nipples.
- B. All connection to Water Heaters, Meters, Pumps, and other equipment requiring maintenance or alteration shall be made up with unions. Unions on brass piping, 2 in. and smaller, shall be brass composition "E" in strict accordance with Federal Specification WW-U-516. On plastic piping, use unions of the same material as the piping.
- C. All close and shoulder nipples shall be corresponding materials as the pipe and shall be extra heavy.

## 2.19 DOMESTIC WATER HEATERS

- A. Furnish and install two natural gas water heaters and one storage tank as detailed on the drawings. The potable domestic water heaters and storage tank shall be by one manufacturer and shall be by Lochinvar, Heat Transfer Products, Laars, or approved equal.
- B. Each water heater shall be a Lochinvar Armor Model AWN401PM having a modulating input rating of 400,000 Btu/Hour each, a recovery capacity of 482 gallons per hour at a 100 deg. F rise and shall be operated on natural gas. The water heater shall be capable of full modulation firing down to 20% of rated input with a turn down ratio of 5:1.
- C. The water heater shall bear the ASME "H" stamp and shall be National Board listed for inputs in excess of 200,000 Btu/Hr. There shall be no banding material, bolts, gaskets or "O" rings in the header configuration. The stainless steel combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly. A built-in trap shall allow condensation to drain from the heat exchanger assembly. The complete heat exchanger assembly shall carry a five (5) year limited warranty.
- D. The water heater shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.10.3 test standard for the US. The water heater shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The water heaters shall operate at a minimum of 95% thermal efficiency. The water heaters shall be certified for indoor installation.
- E. The water heaters shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The water heaters shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating water heater firing rates for maximum efficiency. The water heaters

shall operate in a safe condition at a de-rated output with gas supply pressures as low as 4 inches of water column.

- F. The water heaters shall utilize a 24 VAC control circuit and components. The control system shall have an electronic display for water heater set-up, water heater status, and water heater diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The water heaters shall be equipped with; a high limit temperature control certified to UL353, ASME certified pressure relief valve, outlet water temperature sensor, inlet water temperature sensor, a UL 353 certified flue temperature sensor, low water flow protection and built-in freeze protection. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping.
- G. The water heaters shall feature the “Smart System” control with a Multi-Colored Graphic LCD display with Navigation Dial and Soft Keys, password security, pump delay with freeze protection, pump exercise, and USB PC port connection. The water heaters shall feature night setback for the domestic hot water tank and shall be capable of controlling a building recirculation pump while utilizing the night setback schedule for the building recirculation pump. The water heater shall have the capability to accept a 0-10 VDC input connection for BMS control of modulation or set-point and enable/disable of the water heater, and a 0-10VDC output of water heater modulation rate. The water heaters shall have a built-in cascading sequencer with modulation logic options of “lead lag” or “efficiency optimized”. Both modulation logic options should be capable of rotation while maintaining modulation of up to eight water heaters without utilization of an external controller. Supply voltage shall be 120 volt / 60 hertz / single phase.
- H. The water heaters shall be equipped with two terminal strips for electrical connection. A low voltage connection board with data points for safety and operating controls, i.e., Auxiliary Relay, Auxiliary Proving Switch, Alarm Contacts, Runtime Contacts, Manual Reset Low Water Cutoff, Flow Switch, High and Low Gas Pressure Switches, Tank Thermostat, Tank Sensor, Building Management System Signal, Modbus Control Contacts and Cascade Control Circuit. A high voltage terminal strip shall be provided for supply voltage. The high voltage terminal strip plus integral relays are provided for independent control of the Domestic Hot Water Pump and Building Re-circulation Pump. All low voltage control wiring between water heater and storage tank shall be provided by Division 22.
- I. The exhaust flues shall be stainless steel sealed vent material, as specified, terminating at the roof top with the manufacturers specified vent termination. A separate pipe shall supply combustion air directly to the water heater from the outside. The air inlet shall be stainless steel as specified. The air inlets must terminate using the manufacturers specified air inlet cap. The water heater’s total combined air intake length shall not exceed 100 equivalent feet. The water heater’s total combined exhaust venting length shall not exceed 100 equivalent feet.
- J. Water heaters shall have direct spark ignition with electronic supervision firing control system.

- K. Furnish and install condensate neutralizing kit with each water heater. Run condensate piping, after neutralized, to the nearest floor drain.
- L. The circulating pump shall be all bronze and operate on a 120 volt, 60 cycle, 1 phase power supply. The pump shall be wired to run with intermittent pump operation.
- M. Furnish and install one vertical water storage tank. Storage tank shall be a Lochinvar Lock-Temp RCA0318 tank having a storage capacity of 318 gallons. The tank shall be constructed with an inner chamber designed to receive all circulation to and from the water heater to eliminate turbulence in the tank. The baffled tank shall supply 80% of tank capacity without a drop in outlet temperature. The storage tank shall be constructed in accordance with ASME requirements. The storage tank shall have a working pressure of 150 psi. The storage tank shall be cement lined and carry a five (5) year limited warranty. The tank shall be constructed with a heavy gauge galvanized steel jacket assembly, primed and pre-painted on both sides. The jacket and tank base shall be a water tight construction with a built-in drain pan, complete with a 3/4" drain connection. The Storage Tank shall be completely encased in high density insulation of sufficient thickness to meet the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The entire assembly shall be mounted on "I" beam skids to facilitate handling and installation.
- N. Expansion Tank: Furnish and install as shown on plans a 35 gallon(12 gallon acceptance volume), 16" diameter x 45" (high) pre-charged steel thermal expansion tank with a fixed FDA approved butyl bladder. The tank shall have a top NPT stainless steel system connection and a .301" - 32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 150 psi working pressure. Tank shall be Wessels model number TTA-80 or by Amtrol, Taco, or approved equal.

## 2.20 SELF REGULATING ELECTRIC HEAT TRACE (FOR LHW PIPING)

- A. Acceptable manufacturers:
  - 1. Thermon, Model -HSX
  - 2. Penair
  - 3. Raychem
- B. Furnish and install a UL listed system of heaters and components for maintaining the water temperature for the non potable hot water piping.
- A. Manufacturer shall submit catalog cuts showing materials and performance along with detailed shop drawings indicating pipe to be heat traced, splices, power connections and other components for the Engineer's approval.
- B. The self-regulating cable shall consist of two (2) 14 AWG nickel plated copper bus wires embedded in a crosslinked parallel conductive polymer as the heating element.



- C. The heater shall vary its output all along its length to maintain the selected temperature of the system 115° F and operate on 120 volt, single phase power.
- D. The heater shall be tinned copper braid covered by a radiation cross linked polyolefin dielectric jacket.
- E. Power retention of the heating element shall be a minimum of 90% after 1000 hours of exposure in an oven at 185° F while energized or 300 cycles between 50 F and 212° F.
- F. Power connection, end seal, splice and tee components shall be applied in the field.
- G. Manufacturer shall have more than 10 years experience with self regulating heating cables for temperature maintenance of domestic hot water.
- H. Measure the heater circuit continuity and the insulation resistance between the braid and bus wires with a 2500-Vdc megohmmeter (meggar).
- I. The tests should be performed after the pipe insulation has been installed and prior to installation of wall or ceiling panels and shall be witnessed by the Construction Manager and the manufacturer or the manufacturer's representative.
- J. The heater circuit shall be continuous and meggar readings shall be at least 20 megohms regardless of heater length. Circuits yielding unacceptable readings must be repaired or replaced.
- K. The heater shall be a single cable for all pipe sizes.
- L. Provide circuit breaker with 30 MA ground fault protection.
- M. Electric heat trace system manufacturer shall furnish shop drawings for each system including cable layout, load chart and circuit description.
- N. Refer to the manufacturer's hot water temperature maintenance design guide for design details, insulation requirements, maximum circuit lengths and accessory information.

## 2.21 TEMPERING VALVES

- A. Tempering valves shall be as manufactured by Powers, Symmons, Leonard or equal.
- B. Furnish upon completion of all work, certificates of inspections from the manufacturers stating that authorized factory engineers have inspected and tested the operation of their respective equipment and found same to be in satisfactory operating conditions.
- C. Thermostatic Master mixing valve (TM-1 in Mech. room) : Complete Water Temperature Control station to maintain the return water temperature within the range off 100 degree F to 140 degree F. Valve must compensate for temperature fluctuation due to inlet temperature or pressure changes. Wetted surface of the product must comply lead free requirements and state code. The large and small mixing valve shall be equipped with adjustable high temperature limit stop set,

color coded dial, locking temperature regulator, inlet union angle strainer checkstops. All bronze, brass and stainless steel construction. The station shall be preassembled and tested for complete control station and ASSE 1017 listed and shall be capable to interface with building management system.. The station shall include return circulator as specified on schedule, aquastat, automatic balancing valve and bypass line. The temperature control mixing valve shall be equal to Leonard model 4NB-LF with building management controller BMSI.

- D. Thermostatic mixing valve for individual Emergency Showers (TM2). The shower shall ASSE 1071 certified and meet ANSI Z358.1-2009 requirement. The valve shall be equal to Guardian G3700 furnish in stainless steel cabinet and lockable latch. The valve shall be directly linked to control the hot and cold water intake and blend to deliver tepid water (75F adjustable). The valve shall be capable of supplying 3 to 34 gpm of tepid water at maximum 20 psi pressure drop. In event of restriction or failure of hot water supply, internal bypass shall allow valve to deliver cold water to emergency unit. In bypass mode, valve shall deliver 20 gpm at 30 psi drop. In event of loss of cold water supply, valve shall close and shall not deliver water
- E. Point of use mixing valve for single or multi lavatory faucets: Lead free, Thermostatic Mixing Valves with bronze body, Thermostatic wax element design, locking temperature adjustment knob, integral check valves on inlets and ball shut off valve. Minimum flow 0.35 gpm and maximum flow 4.6 gpm. Mixing valve shall be equal to Chicago Faucets 131 ABNF / 131 CABNF or equal.
- F. Furnish and install a 4 in. diameter thermometer on the outlet side of each tempering valve as manufactured by U.S. Gauge Company, Powers Regulator Company, and/or Trerice Company.

## 2.22 RECIRCULATING HOT WATER PUMPS

- A. Circulators shall be all-bronze booster type, Grundfos Magna3 40-80 or equal by Bell & Gossett, Taco or approved equal.
- B. Circulators shall be connected to the Building Management System by Division 23.

## 2.23 TRAP PRIMERS

- A. The trap primer shall be as manufactured by Precision Plumbing Products, Inc., Jay R. Smith, MIFAB or approved equal.
- B. Furnish and install trap primer units to serve one or two drains. Provide trap primers to all floor drains as required by 248 CMR Plumbing code.
- C. For one or two floor drains, the trap shall be Precision Plumbing Products, Inc. Model P2-500, 1/2" connections, automatic brass trap primer units which shall be activated by a drop in water pressure (minimum 3 psi) in the active cold water line in which attached. Units shall meet Code and ASSE Standard #1018. Units shall be adjustable to line pressure and desired delivery amount. Units shall deliver a maximum of two ounces of water on a 15 second pressure drop and have corrosion resistant brass fittings with a copper reservoir with clear plastic inspection cover, and mounting brackets, "O" ring seals.
- D. Electronic Trap Primer (ETP) for multiple floor drain, the trap primer unit shall be equal to Precision Plumbing Products Model PTS-2130. The electronic Time Trap priming manifold (ETP) shall supply 2 oz water at 20 pasi at a preset 10 second every 24 hours. The manifold steel cabinet shall include , vacuum breaker, pre-set 24 hour time clock, manual override switch, 120V solenoid valve, 3 wire connection, NPS 3/4 inlet connection, manifold, compression outlet fittings, inlet shut off valve
- E. Install units one foot above the flood level of the device served for every 20 feet of primer line. Pipe according to manufacturer's instructions, off top of supply line, and 15-1/4" down to bottom of distribution units.
- F. Units serving multiple devices shall be furnished with #SS-8 straight supply tube and #DV-2 distribution unit.
- G. Plumbing Subcontractor shall adjust all units and cycle all primers at least six times to insure proper activity.

## 2.24 BOILER/WATER HEATER AIR INTAKE AND EXHAUST BREECHING, CHIMNEYS AND STACKS

- A. The air intake and exhaust vents shall be double-wall stainless steel, factory-built type for use on condensing appliances.
- B. Maximum temperature shall not exceed 550°F.
- C. Vent shall be listed for an internal static pressure of 6 in. w.g. and tested to 15 in. w.g.
- D. Vent shall be constructed with an inner and outer wall, with a 1 in. annular insulating air space.
  - 1. The inner wall (vent) shall be constructed of AL29-4C superferritic stainless steel, .015 thickness for 4 in.-12 in. diameters and .024 thickness for 14 in.-24 in. diameters.

2. The outer wall (casing) shall be constructed of type 430 stainless steel, .018 thickness for 4 in.-12 in. diameters and .024 thickness for 14 in.-24 in. diameters.
  3. Inner and outer walls shall be connected by means of spacer clips that maintain the concentricity of the annular space and allow unobstructed differential thermal expansion of the inner and outer walls.
- E. All parts exposed to the weather shall be stainless steel.
- F. All supports, roof or wall penetrations, terminations, appliance connectors and drain fittings, required to install the vent system shall be included.
- G. Roof penetration pieces shall be UL listed and provided by the vent manufacturer.
- H. All inner vent connections shall be secured by means of profiled connector bands with gear clamp tighteners. Joints shall be sealed with waterproof sealant. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.
- I. Vent shall terminate in accordance with installation instructions and local codes.
- J. Manufacturers: Subject to compliance with requirements, provide all steel, insulated, positive pressure double wall vents of one of the following:
1. Metal-Fab, Corr/Guard Model CG
  2. Selkirk Heat-Fab Saf-T Vent CI
  3. Schebler eVENTplus
  4. or equal

#### 2.25 CONDENSATE NEUTRALIZING TUBES

- A. Contractor shall furnish and install condensate neutralizing tubes for new boilers and domestic water heater condensate drains and flue pipe condensate drains.
- B. Neutralizer tubes shall be as manufactured by JJM Boiler Works, Neutra-Safe, Fireside Condensate Neutralizers, or approved equal, and sized according to input rating of each piece of equipment.
- C. The boiler/water heater and flue condensate drains shall not be combined, Provide separate neutralizing tubes for boiler/water heater and flue condensates. All piping shall be per manufacturer's piping diagrams and directions. Secure neutralizing tubes to the floor.

#### 2.26 -----NOT USED-----

#### 2.27 MAIN HOUSE WATER METER

- A. The main house water meter shall be in accordance with the requirements of the local water department. Water meter shall be lead free, compound type,

conforming to AWWA Standards. Size meter and arrange piping and specialties to comply with utility company requirements.

- B. The meter shall be the remote reading type with the radio remote read device mounted in an acceptable location.
- C. Shut-off valves shall be installed on both sides of the meter and a strainer shall be installed on the inlet side of the meter after the inlet shut-off valve. Provide bypass per local requirements.

## 2.28 WATER SUB METERS (SM1 to SM3)

- A. Water sub meter shall record water supply and shall be provided as shown on the drawing. Refer to drawing P0.01 for sub meter application diagram.
- B. Provide water meter for flow measurement of potable water supply to the school facility and shall be capable to integrate with building control management system. Provide BACnet MS/TP control interface module for communication with BMS system. The water meter shall be a non-intrusive kind that requires no cutting of pipe or drilling of a hole. The device shall not be in contact with the water and thus it shall not cause pressure drop.
- C. Design of the water meter shall use transit-time ultrasonic technology along with transducers to provide for flow totalizing (gallons used) and flow rate (gpm) in real time. Water meter (s) shall be wall –mounted and capable for +1% accurate flow measurement of clean liquids, suitable for liquids that contain small amounts of suspended solids or particle in sizes smaller than 100 um in order to make a measurement. The meter shall be able to operate in temperatures ranging from 32°F to 212°F and come equipped with a device that emits pulse signals.
- D. The clamp-on sub-meter shall contain a display that is LCD with backlight. Indication for flow rate and flow accumulator shall be displayed in English (US) units.
- E. Clamp-on transducers that are strapped to the water lines and wired directly to the sub-meter electronics enclosure must be provided as part of the potable water sub-metering system.
- F. The input/output interfaces and RD485 port to integrate with building management system.
- G. Enclosure shall be weather-resistant, NEMA 4X or IP65. It shall be constructed of stainless steel
- H. Acceptable Manufacturers and Models are EF10-WA-DC12 by Spire Metering, STUF -300FxB by SHENITECH, TFX by Dynasonics; or equal
- I. Shut-off valves shall be installed on both sides of the meter. Provide bypass with shut off valve around water sub meter.

## 2.29 GAS SUB-METER

- A. The Plumbing Subcontractor shall furnish and install gas sub-meter(s), which are

to be integrated with the building management system (BMS). Interfacing gas sub-meters with the BMS shall allow for recording data on gas consumption, registering gas load trending and monitoring of gas pressure delivered to gas-burning equipment.

- B. Gas meter shall be provided to monitor the facility total gas consumption.
- C. Gas sub-meter(s) shall provide accurate mass flow measurement utilizing pipe insertion type flow measuring probe and readout display. The meter shall provide low pressure drop across the sub-meter and shall be designed with high rangeability at 40:1 and 1% accuracy. Sub-meter(s) shall contain inherent feature that provides for temperature compensation.
- D. The meter shall be capable of providing 4-20mA output and pulse output and shall be capable of transmitting signal outputs to the energy management system.
- E. The meter shall be UL tested and approved by the Massachusetts plumbing board.
- F. Acceptable manufacturers are Onicon F-5300, Fox Thermal Instruments, EPI flow or equal.

#### 2.30 GAS PRESSURE TRANSMITTER

- A. This device is to be furnished, installed and wired by the temperature control contractor. Plumbing Subcontractor shall provide a fitting for insertion of the gas pressure sensor into the supply header piping to gas-fired equipment and sensor well in piping.

#### 2.31 ELEVATOR SUMP PUMPS

- A. Furnish and install in each elevator pit Stancor Environmental Oil Minder Pump and Control System consisting of a NEMA 4x weather-tight corrosion resistant fiberglass enclosure, stainless steel sensor probe and Stancor Model SE-50 Submersible Sump Pump, wired for 120V. Single phase power; ½ HP.

#### 2.32 ACID NEUTRALIZATION SYSTEM

- A. Furnish and install complete acid neutralization and PH monitoring systems including all piping, equipment, and interconnection power and control wiring from power panel to all components. Power to panel is furnished under the Electrical Section of the Specifications. Plumbing Subcontractor is responsible to furnish and install using properly licensed personnel all conduit and wiring between the panels and monitoring points. All materials and methods used for this wiring shall be consistent with the requirements of Division 26. Furnish for installation by General Contractor, access hatch detailed on drawings.
- B. System shall be as manufactured by Burt Process Equipment and consist of the following:
  - 1. Acid neutralizing tanks shall be polyethylene type with fitted with inlet, outlet, and vent connections as detailed on Drawings. Tanks shall be installed as

- shown on the drawings. Include full charge of limestone chips and a second charge of chips.
2. PH sensors shall be compatible with controller, encapsulated electrodes with automatic temperature compensation, measuring range of 0-14 PH sensitivity, and have 2 conductor shield cable.
  3. PH receivers to accept 4-20 MA signal, with both digital and simulated analog display capabilities.
  4. The recorders shall be strip chart type, single pen with a 2-5/16" chart width. The chart shall record for a minimum of 30 days. The unit shall operate on a 0-1 MA signal with a power requirement of 115v AC 60 Hz.
  5. Receivers and recorders shall be housed in a NEMA IV styrene enclosure with single weatherproof door.
  6. Control panels shall be completely pre-wired and pre-tested, NEMA IV type enclosure, wall mounted, hinged and locked front panel with components as follows:
    - a. Receiver/Analyzer
    - b. Strip Chart Recorder
    - c. PH Out of Spec Hi/Lo Alarms
    - d. System On/Off Switch
    - e. Alarm Test and Silence Buttons
  7. U-Trap Assembly shall be heat fusion jointed polypropylene pipe and fittings with an extension section to house the effluent PH probe.
  8. All components and instrumentation for the neutralization systems shall be furnished for installation from a single source and shall be installed in strict accordance with the manufacturer's recommendations.
  9. System calibration and start-up shall be included in the package provided by the manufacturer. The manufacturer shall also be responsible for conducting a training seminar for the site facilities people prior to the system being turned over to the Owner (minimum 4 hours).
  10. The manufacturer, as part of his package, shall be responsible for making not less than three visits during the first year of operation to check up on the workability of the system.

### 2.33 GREASE TRAPS

#### A. General

1. Grease trap shall be as manufactured by Rockford Separators, Jay R. Smith, MIFAB, Zurn or approved equal.
2. GI-1 & 2 : Furnish and install fully recessed grease Interceptor and shall be equal to Jay R. Smith 8450 integral with extension, 75 GPM flow rate, 150 lbs capacity, 4" inlet & outlet, Steel interceptor with integral extension with gray Duco coating inside and outside and Flow control fitting. The grease trap shall bear the seal of approval from the Plumbing Drainage Institute and Mass approved product.

### 2.34 MANHOLE AND PRECAST CONCRETE OIL/GAS SEPARATOR STRUCTURE

- A. The Oil/Sand Trap shall be installed in accordance to Massachusetts Plumbing Code 248 CMR 10.22. and as detailed on the drawing.
- B. Manholes and precast concrete structures shall be constructed as shown on Drawings. Conform accurately to indicated dimensions.
  1. Precast concrete manhole barrel, base, and cone sections shall conform to ASTM C-478 and shall be furnished complete with integral cast aluminum polymer coated steel steps. Sections shall be assembled with Kentseal #2 gaskets, or equal.
  2. Brick for constructing channels and adjustments to grade shall be waterstruck sewer brick, Grade 'A' concrete brick conforming to ASTM C-55, or precast concrete grade rings mortared in place.
  3. Cement mortar for parging and for joining brick shall be made of one (1) part portland cement and two (2) parts sand mixed to the proper consistency. Add approximately twenty (20) pounds of hydrated lime for each sack of cement.
  4. Precast concrete structures for oil/gas separator shall be as manufactured by A. Rotondo & Sons, Inc. or equal by Scituate Concrete pipe or Shea precast. Structures shall conform to the form and dimensions shown, be reinforced with ASTM A-615-79 Grade 60 reinforcing steel having a minimum 1" cover, and constructed of 5,000 PSI concrete. All field joints shall be sealed with rubber gasket and shall be grouted with hydraulic cement for watertightness. Design loading for all structures shall meet H-20 wheel loading design
- C. Conform to the Concrete Section of the specification for 4,000 PSI 6% air entrained concrete for all concrete structures for the work of this section. Including reinforcing steel where detailed.
- D. Cast iron manholes, frames, and covers, shall be of the form, dimensions, and manufacture shown on the Contract Drawings. Manhole extensions shall be neatly and accurately brought to dimensions of the base of the frame. Casting shall be of tough gray iron, free from cracks, holes, and cold shuts. All castings shall be made accurately to dimensions and shall be machined to provide even bearing surfaces. Covers must fit the frames in any position and, if found to rattle under traffic, shall be replaced. Filling to obtain tight covers will not be permitted.



No plugging, burning-in, or filling will be allowed. All castings shall be carefully coated inside and out with coal tar pitch varnish of approved quality.

- E. Castings shall be as detailed on drawings or castings that appear on the Massachusetts Highway Department approval list for manhole frame & cover castings. Castings shall be by LeBaron Foundry, Neenah Foundry, or Campbell Foundry.

2.35 SOLID (PLASTER) INTERCEPTOR

- A MIFAB Model Z-1180, Jay R Smith Josam or approved equal large capacity steel interceptor with acid resistant coating, diffusing screens, sediment bucket and gasket screw down cover. The interceptor shall be installed at each art room sink. Interceptor at barrier free fixtures shall be installed in adjacent casework to maintain accessibility clearance.

2.36 PRECAST CONCRETE GREASE TRAP (OUTDOOR INTERCEPTOR)

- A. Precast concrete grease trap:

1. Grease trap shall have 5,000 gallon capacity with an exterior dimension of approximately 8'-0" high, 8' -10" wide, 16' - 0" long. Grease trap shall include 6 in. cast iron inlet and outlet tees.
2. Precast concrete grease trap shall be designed for AASHTO HS-20 loading and have steel reinforcement in accordance with ASTM A-615-75 Grade 60, 1" Minimum Cover.
3. Tank shall have a concrete minimum strength of 5,000 P.S.I. @ 28 days.
4. Grease trap shall be constructed with tongue and groove joints between sections. Joints between sections shall be sealed with preformed rubber gaskets conforming to ASTM C 443.
5. Exterior surfaces of grease trap shall receive a heavy shop-applied coating of bituminous waterproofing equal to:

<b>Product</b>	<b>Manufacturer</b>
Super Service Black	Koppers Company, Inc.,
Pittsburgh, PA No. 46-449 HD Black	Themec Company,
Inc., North Kansas, MO No. 35-J-10 Hi Built	Mobile
Chemical Company,	
Bituminous Coating	Edison, NJ

6. Each section of the grease trap shall have no more than 2 suitable lifting holes or cast-in lifting devices.
7. Precast grease trap shall be manufactured with wall openings to receive the ends of pipes which are to be connected to structure. Pipe openings in base shall be minimum size required to receive pipe, and shall be accurately set to conform to the required line and grade.

- B. Precast concrete grease trap shall be similar to those be manufactured by:

1. Old Castle Precast, Rehoboth, MA
2. Scituate Ray Precast, Scituate, MA

3. E.F. Shea New England Concrete Products., Wilmington, MA

#### 2.37 FIRESTOP SYSTEMS

- A. General: Provide firestopping at all new fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 078400 - Firestopping, for all product requirements for maintaining integrity of fire-rated construction at penetrations.

#### 2.38 SCAFFOLDS AND STAGING

- A. General: Trade Contractors shall obtain required permits for, and provide scaffolds, staging, and other similar raised platforms, required to access their Work as specified in Section 01 50 00 - Temporary Facilities and Controls and herein.
  1. Scaffolding and staging required for use by this Trade Contractor pursuant to requirements of Section 01 50 00 - Temporary Facilities and Controls shall be furnished, erected, maintained in a safe condition, and dismantled when no longer required, by this Trade Contract requiring such scaffolding.
  2. Each Trade Contractor is responsible to provide, maintain and remove at dismantling, all tarpaulins and similar protective measures necessary to cover scaffolding for inclement weather conditions other than those required to be provided, maintained and removed by the General Contractor pursuant to MGL (Refer to Section 01 50 00 - Temporary Facilities and Controls and as additionally required for dust control).
  3. General Contractor is responsible to provide enclosures required for temporary heat; refer to Section 01 50 00 - Temporary Facilities and Controls.
    - a. Furnishing portable ladders and mobile platforms of all required heights, which may be necessary to perform the work of this trade, are the responsibility of this Trade Contractor.

### 2.39 HOISTING MACHINERY AND EQUIPMENT

- A. All hoisting equipment, rigging equipment, crane services and lift machinery required for the work by this Trade Contractor shall be furnished, installed, operated and maintained in safe conditions by this Trade Contractor, as referenced under Section 01 50 00 - Temporary Facilities and Controls.

## PART 3 - EXECUTION

### 3.1 WORKMANSHIP AND INSTALLATION METHODS

- A. All work shall be installed in a first-class manner consistent with the best current practices. All materials shall be securely installed plumb and/or level, and all flush mounted equipment shall have front edge flush with finished wall surface.
- B. All piping shall be installed true to line and grade in the case of underground piping. All piping above ceilings or exposed shall be grouped together, be parallel to each other, and be either parallel or perpendicular to the structure. Utilize gang hangers wherever feasible. Group all valves together where feasible.
- C. Training:
  - 1. Train the Owner's maintenance personnel on troubleshooting procedures, and servicing and preventative maintenance schedules and procedures.
  - 2. Schedule training with Owner through the Architect with at least 7 days prior notice.

### 3.2 WORK COORDINATION AND JOB OPERATIONS

- A. The equipment shall not be installed in congested and possible problem areas without first coordinating the installation of same.
- B. Particular attention shall be directed to the coordination of piping and other equipment installed in the ceiling areas. Coordinate the elevations of all piping in hung ceiling areas to insure adequate space for the installation of recessed lighting fixtures before other mechanical equipment is installed.
- C. Furnish to the General Contractor, and all other Subcontractors, all information relative to the portion of the Plumbing installation that will affect them, sufficiently in advance so that they may plan their work and installation accordingly.
- D. In case of failure to give proper information as indicated above sufficiently in advance, pay for all back-charges for the modification, renovation, and relocation of any portion of the work already performed.
- E. Obtain from the other trades, all information relative to the Plumbing Work to be executed in conjunction with the installation of their respective equipment.

### 3.3 CUTTING AND CORE DRILLING

- A. Perform all cutting and core drilling operations that are outlined in Part 1 of this SECTION. Throughout the performance of the cutting and coring work, ensure that the structural integrity of the walls, floors, overhead structure, and other structural components, which are to remain, is maintained until permanent work is installed. Prior to any coring or cutting, verify all locations of same with the General Contractor. All cutting and coring is to be performed in accordance with approved Coordination Drawings
- B. Cut all masonry and concrete with an approved diamond blade concrete saw in a neat straight direction, perpendicular to the plane of the wall or floor.
- C. Use a core drilling process which produces clean, sharp edges and the minimum hole size which will accommodate the size of pipe sleeve specified. Submit procedures for cutting thru existing steel beams to Architect for review.
- D. The patching of holes shall be performed by Plumbing Sub-contractor utilizing methods outlined for the finish trade involved. Holes shall be patched to the satisfaction of the Architect.

### 3.4 CLEANING AND PROTECTION

- A. Protect all materials and equipment during shipment and so as to prevent damage. Water closets, lavatories, and sinks shall be boarded over and all other fixtures shall be protected with pasted on paper. Post notice prohibiting the use of the fixtures prior to completion. Assume full responsibility for protection of work until its completion and final acceptance.
- B. Keep the premises reasonably clean at all times and remove rubbish caused by the Plumbing Work as directed by the Architect.
- C. Upon completion of this work, clean all fixtures and equipment installed herein and replace damaged parts. Failure to fulfill this obligation will result in back-charges for correction of the defective work.

### 3.5 SLEEVES, INSERTS, AND ESCUTCHEONS

- A. All piping passing through slabs, floors, walls, partitions, foundation walls and grade beams, shall be sleeved and all such sleeves shall be furnished and installed by the Plumbing Subcontractor as detailed on the Drawings and herein specified. Set sleeves in concrete floors and walls as soon as forms are set and before concrete is poured. Core drilling openings shall have a sleeve caulked and grouted in place.
- B. All pipes passing through floor, whether slab-on grade or above grade levels, shall be sleeved with sleeve extending 1 in. above floor. This includes all piping in toilet room pipe space, stairwells, closets, partitions and pre-cast planks.

- C. All sleeves shall be Schedule 40 galvanized steel and shall be reamed. There shall be a minimum of 1 in. annular space between the sleeve and pipe provide greater clearance where seismic requirements dictate. Sleeves on insulated pipe shall be large enough to allow insulation to pass through sleeve. Sleeves on drywall, masonry, or concrete walls and partitions, shall be flush with wall on both sides.
- D. The space between sleeve and pipe in all cases shall be filled with a U.L./F.M. approved caulking compound. This includes pipes concealed in chases and/or partitions.
- E. Inserts where required shall be furnished and set by the Plumbing Subcontractor and where necessary may be drilled or power driven and shall be sized such that the insert will not exceed a depth of penetration of 1 in. into concrete.
- F. Escutcheons: All exposed pipe, uncovered, passing through walls or floors or ceilings shall be fitted with C.P. brass spun or split type escutcheons with approved clamping device for holding in position. Floor escutcheons shall be deep enough to fit over sleeves, fastened to pipe, and extend down to floor.

### 3.6 TESTING

- A. Test all Work in the presence of the Architect and/or Engineer and as required by Local Codes.
- B. After Soil, Storm, Special Waste, and Vent Piping is in place and before being buried or furred in, plug lower ends and fill the system with water up to the top of stacks. Piping is to be left tight under these conditions and water level shall be maintained intact for the period of at least four (4) hours.
- C. Test all water piping by applying a hydrostatic pressure of 150 PSIG using a pump for this purpose. Make sure that all lines are properly plugged or capped and that air has been vented before applying pressure which shall remain constant without pumping for two (2) hours at least.
- D. Test gas piping per State Gas Code.
- E. Any leaks in joints or evidence of defective pipe on fittings disclosed by test shall be immediately corrected by replacing defective parts with new joints or materials. No makeshift repair effected by caulking threaded pipe with lead wool, application or Wilky or patented compounds will be permitted.
- F. Gas/Oil Separator Manhole Exfiltration Test:
  - 1. Plug pipes in manhole; remove water in manhole; observe plugs over period of not less than 2 hours to ensure there is no leakage into manhole.
  - 2. Fill manhole with water to within 4 inches of top of cover frame. Prior to test, allow manhole to soak from minimum of 4 hours to maximum of 72 hours; after soak period, adjust water level inside manhole to within 4 inches of top of cover frame.

3. Measure water level from top of manhole frame; at end of 4 hour test period, again measure water level from top of manhole frame; there shall be no drop in water level during test period.
4. When unsatisfactory test results are achieved, repair manhole and retest until result meets criteria; repair visible leaks regardless of quantity of leakage.

G. Provide testing report for all systems tested.

### 3.7 CHLORINATION

- A. Upon completion of the Plumbing Work, thoroughly chlorinate the entire domestic water system before putting same in service. Chlorinate all work in the presence of the Architect and/or Engineer. The chlorinating agent shall be as a solution of sodium hypochlorite. Water shall be fed slowly into the new line with chlorine in the proper amount to produce a dosage of 50 PPM. Open and close all valves while system is being chlorinated.
- B. After the sterilization agent has been applied for 24 hours, pay for an independent testing agency to test for residual chlorine and for presence of bacteria. A residual of not more than 5 PPM shall be required in all parts of the line.
- C. If test show 5 PPM or greater of residual chlorine, flush out system until all traces of the chemical used are removed.
- D. Provide testing report from independent testing agency.

### 3.8 INSTALLATION OF FIRESTOP SYSTEMS

- A. General: Install firestop systems at all fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 078400 - Firestopping, for all installation requirements for maintaining integrity of fire-rated construction at penetrations.

### 3.9 INSTALLATION OF AIR INTAKE AND EXHAUST BREECHING, CHIMNEYS AND STACKS

- A. VIBRATION CONTROL AND SEISMIC RESTRAINT: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.
- B. Install all gas vents/intakes in accordance with manufacturer's installation instructions and UL listing. Maintain minimum clearances from combustibles specified in UL listing.
- C. Seal joints between sections of positive pressure vents in accordance with manufacturer's installation instructions, and using only sealants recommended by manufacturer.

- D. Support vents at intervals recommended by the manufacturer to support the weight of the vent and all accessories, without exceeding loading of appliances. Provide guy wires on all vents which terminate through roof.
- E. Install barometric and thermostatically operated dampers in accordance with manufacturer's instructions. Locate as close to draft hood collar as possible.
- F. Clean breechings internally during installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth.
- G. Temporary Closure: At ends of breechings and chimneys which are not completed or connected to equipment, provide temporary closure which will prevent entrance of dust and debris until installations are completed.

### 3.10 SEISMIC RESTRAINTS

- A. The independent engineer responsible for design of seismic restraints shall visit the project upon completion of the work to certify the installation is consistent with the approved shop drawings. The certification shall be submitted to the Architect and must precede the closing in of ceilings.

### 3.11 SYSTEM SHUTDOWNS

- A. Coordinate shutdowns of existing systems with the Owner and submit a written request at least ten working days in advance. Minimize system shut downs as much as possible. Submit a list of all affected areas, the proposed work to be performed, and the expected length of the shut-down including time for retesting.
- B. Provide temporary services to maintain active system during extended shut-downs as required for demolition and construction phasing.

END OF SECTION

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Section 22 08 00

COMMISSIONING OF PLUMBING

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This section includes commissioning process requirements for Plumbing systems, assemblies, and equipment.
- B. Related Sections:
  - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "General Commissioning Requirements" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's role.
- B. Refer to Division 01 Section "Submittals" for specific requirements. In addition, provide the following:
- C. Certificates of readiness
- D. Certificates of completion of installation, prestart, and startup activities.
- E. O&M manuals
- F. Test reports

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

**PART 2 - PRODUCTS**

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the contractor for the equipment being tested. For example, the plumbing contractor of Division 22 shall ultimately be responsible for all standard testing equipment for the plumbing system in Division 22, except for equipment specific to and used by TAB in their commissioning responsibilities.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL DOCUMENTATION REQUIREMENTS**

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.
- B. Red-lined Drawings: The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. Operation and Maintenance Data: Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the contractor.
- D. Demonstration and Training: Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior to the training session.

#### **3.2 CONTRACTOR'S RESPONSIBILITIES**

- A. Perform tests as required by Division 22.
- B. Attend construction phase controls coordination meetings as required.
- C. Participate in Plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- D. Provide information requested by the CxA for final commissioning documentation.
- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Plumbing system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, testing and balancing and task completion for owner. Distribute preliminary schedule to commissioning team members.
- G. Update schedule as required throughout the construction period.
- H. Assist the CxA in all verification and functional performance tests.

- 
- I. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
  - J. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
  - K. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
  - L. Notify the CxA a minimum of two weeks in advance of the time for start of the balancing work..
  - M. Participate in, and schedule vendors and contractors to participate in the training sessions.
  - N. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
    - 1. Plumbing equipment including domestic water heaters, controls, pumps, valves plumbing fixtures, and all other equipment furnished under this Division.
  - O. The equipment supplier shall document the performance of his equipment.
  - P. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
  - Q. Balance Contractor
    - 1. At the completion of the balancing work, and the submittal of the final balancing report, notify the Plumbing contractor and the CM/GC.
  - R. Equipment Suppliers
    - 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
    - 2. Assist in equipment testing per agreements with contractors.
    - 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
  - S. Refer to Division 01 Section "General Commissioning Requirements" for additional contractor responsibilities.
- 3.3 CxA'S RESPONSIBILITIES
- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's Responsibilities.

### 3.4 TESTING PREPARATION

- A. Certify in writing to the CxA that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the CxA that Plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.5 DOMESTIC WATER BALANCING

- A. Notify the CxA at least ten (10) days in advance of testing and balancing Work, and provide access for the CxA to witness balancing Work.

### 3.6 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Plumbing testing shall include entire Plumbing installation. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the Plumbing contractor, balancing subcontractor shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.

- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

### 3.7 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 22 sections. Provide submittals, test data, inspector record, and certifications to the CxA.
- B. Plumbing Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 22 Sections. Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment: Test requirements are specified in Division 22 piping Sections. Plumbing Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
  - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
  - 2. Description of equipment for flushing operations.
  - 3. Minimum flushing water velocity.
  - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Plumbing Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of domestic water distribution systems.
- E. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls as required.

- F. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

<b><i>Plumbing Systems</i></b>
Natural gas systems
Compressed air systems
Backflow preventers
Water heaters
Hot water storage
Recirculation pumps
Water closets and sinks
Laboratory waste and acid neutralization systems
Safety shower/eyewash stations
Mixing valves
Rain water reclamation systems

- 3.8 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT
- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.
- 3.9 APPROVAL
- A. Refer to Division 01 Section "General Commissioning Requirements" for approval procedures.
- 3.10 DEFERRED TESTING
- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deferred testing.
- 3.11 OPERATION AND MAINTENANCE MANUALS
- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 Section "General Commissioning Requirements" for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.12 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to training.

End of Section



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Section 23 00 00  
HEATING, VENTILATING & AIR-CONDITIONING (HVAC)  
(Filed Sub-Bid Required)

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Section 23 00 00  
HEATING, VENTILATING & AIR-CONDITIONING (HVAC)  
(Filed Sub-Bid Required)

**PART 1 - GENERAL**

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.
- B. Examine all other Sections of the Specifications for requirements that affect work of this Section whether or not such work is specifically mentioned in this Section.
- C. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 FILED SUB-BID REQUIREMENTS

- A. Time, Manner and Requirements for Submitting Sub-Bids
  - 1. Sub-bids shall be submitted in accordance with the provisions of Massachusetts General Laws (Ter. Ed.), Chapter 149, Sections 44A-44I, inclusive, as amended. The time, place and manner of submission of sub-bids shall be as set forth in the INSTRUCTIONS TO BIDDERS.
  - 2. Each sub-bid submitted for work under this Section shall be on a form furnished by the Awarding Authority, as required by Section 44F of Chapter 149 of the General Laws, as amended.
  - 3. Each sub-bid filed with the Awarding Authority shall be accompanied by a Bid Bond or Cash or Certified check or a Treasurer's or Cashier's Check issued by a responsible bank or trust company payable to the Awarding Authority in the amount of five percent of the bid. A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.
- B. Sub Sub-Bid Requirements:
  - 1. Sub bidder's attention is directed to Massachusetts G.L. Chapter 149 Section 44F, as amended, which provides in part as follows.
  - 2. Each sub-bidder shall list in Paragraph E of the "Form for Sub-bids" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which the Section of the Specifications for that sub trade requires such listing, provided that, in the absence of a contrary provision in the Specifications, any sub-bidder may, without listing any bid price, list his own name or part thereof and perform that work with persons on his own payroll, if such sub-bidders, after sub-bid openings, shows to the satisfaction of the Awarding Authority that he does customarily perform such class of work with persons on his own payroll and is qualified to do so. This Section of the Specifications requires that the following classes of work shall be listed in Paragraph E under the conditions indicated herein.

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CLASSES OF WORK	REFERENCE PARAGRAPH
Insulation	2.6, 2.7, 3.7, 3.8
Sheetmetal & Accessories	2.17, 2.18, 2.19, 2.20, 2.21, 2.22, 3.19, 3.20, 3.21, 3.22, 3.23, 2.24
Automatic Temperature Controls	2.30, 3.32
Air & Water Balancing	3.33

- C. Reference Drawings: The Work of this Filed Sub-Bid is shown on the following Contract Drawings: M101A, M101B, M101C, M101D, M102A, M102B, M102C, M102D, M103A, M103B, M103C, M103D, M104, M201A, M201B, M201C, M201D, M202A, M202B, M202C, M202D, M203A, M203B, M203C, M203D, M301, M302, M303, M304, M305, M306, M401, M402, M403, M404, M405, M406, VS101.
- D. The listing of the Contract Drawings above shall not limit responsibility to determine full extent of work of this Section as required by: all Contract Drawings noted on the Contract Drawings-Title Sheet Drawing List, the Project Manual, and Addenda.

### 1.3 DEFINITIONS

- A. Most terms used within the documents are industry standard. Certain words or phrases shall be understood to have specific meanings as follows:
1. Provide: Furnish and install completely connected up and in operable condition.
  2. Furnish: Purchase and deliver to a specific location within the building or site.
  3. Install: With respect to equipment furnished by others, install means to receive, unpack, move into position, mount and connect, including removal of packaging materials.
  4. Conduit: Raceways of the metallic type which are not flexible.
  5. Connect: To duct, pipe or wire up, including all branch ductwork, piping, and/or circuitry, control and disconnection devices so item is complete and ready for operation.
  6. Subject to Mechanical Damage: Equipment, ductwork, piping and raceways installed exposed and less than eight feet above finished floor in mechanical rooms or other areas where heavy equipment may be in use or moved.
  7. General Contractor and Construction Manager are one in the same.

### 1.4 DESCRIPTION OF WORK

- A. The work described herein shall be interpreted as work to be done by the HVAC Subcontractor. Work to be performed by other trades will always be specifically referenced to that trade.
- B. Furnish all staging, rigging, temporary support, labor, materials, and perform all operations in connection with the installation of the HVAC work. Refer to Section 015000 for coordination of requirements by this trade contractor.

- 
- C. Without limiting the generality thereof, the work to be performed under this section includes complete new HVAC systems with the following major sub systems:
1. Low Pressure Hot Water, Chilled Water Piping, Make-Up Water, Condensate Insulation and accessories
  2. Refrigeration Piping
  3. Power & Gravity Ventilators
  4. Ductwork With Insulation, Diffusers, Registers And Grilles
  5. Terminal Heating Units including Unit Heaters, Fintube Radiation, Radiant Panels and Electric unit heaters.
  6. Pumps and Accessories
  7. Boilers
  8. Air Cooled Chillers
  9. Rooftop Units
  10. Variable Air Volume Units
  11. Ductless Cooling Unit Systems
  12. Sound Attenuators and Acoustic Liner
  13. Condensate Pumps
  14. Direct Digital Automatic Temperature Controls
  15. Testing and Balancing
  16. Water/Chemical Treatment
  17. Vibration and Seismic Components
- D. Refer to Section 230548 "Vibration Control and Seismic Restraint" for additional work to be provided under this Section 230000.
- E. Refer to Section 078400 – FIRESTOPPING for additional work to be provided under this Section 230000.
- F. It shall be the responsibility of this Division 230000 to provide all personnel to fully coordinate with the commissioning agent. The hours of training and instruction outlined in this Division 230000 and the testing requirements shall be in addition to those tests and requirements outlined in SECTION 019113 – GENERAL COMMISSIONING REQUIREMENTS and required to fulfill Section 230800 -- COMMISSIONING OF HVAC SYSTEMS.
- G. Include the following work as needed to perform the work of this section.
1. Core drilling in accordance with SECTION 017329 – CUTTING AND PATCHING.
  2. Cutting through non masonry and masonry construction in accordance with SECTION 017329 – CUTTING AND PATCHING.
  3. Temporary facilities, including but not limited to stairs and ladders, staging, scaffolding, rigging, chutes and hoisting in accordance with SECTION 015000 – TEMPORARY FACILITIES AND CONTROLS.
  4. Fire and smoke stop systems in accordance with SECTION 078400 – FIRESTOPPING.



- 
5. Furnish access doors and frames in accordance with SECTION 083100 – ACCESS DOORS AND FRAMES.
- H. For LEED requirements refer to SECTION 018110 – SUSTAINABLE DESIGN REQUIREMENTS, SECTION 018119 – INDOOR AIR QUALITY REQUIREMENTS and SECTION 018120 – CONSTRUCTION INDOOR AIR QUALITY (IAQ) MANAGEMENT.
  - I. For Mechanical system commissioning refer to SECTION 230800 – COMMISSIONING OF HVAC SYSTEMS.
  - J. Change all air handling unit (RTU, HVU, MAU, UH, DCU) filters as required by SECTION 018119 INDOOR AIR QUALITY REQUIREMENTS flush out procedures and adhere to IAQ Management Procedures.
  - K. Sustainable Design Intent: Comply with project requirements intended to achieve a minimum score measured and documented according to SECTION 018110 – SUSTAINABLE DESIGN REQUIREMENTS. Project scores will be verified by a third party certifier.
    1. Refer to Section 018110 – SUSTAINABLE DESIGN REQUIREMENTS for material, procedure, and documentation submittal requirements.
    2. High efficiency filters – Install MERV 13 filters in all HVAC equipment requiring filtration media immediately prior to occupancy.
    3. Air intake location – Locate outside air intake openings a minimum of 25 ft. from any hazard or noxious contaminants such as chimneys, plumbing vents, cooling towers, streets, alleys, parking lots, and loading docks. The distance between exhaust air or vent outlets and air intakes should be the greater of 25 ft. or the distance as determined by MA State Building Code Equation 2801.2.2.2. Exception, when locating an air intake within 25 ft. of a contaminant source is unavoidable, such opening shall be a minimum of 2 ft. below the contaminant source and 10 ft. horizontally from the nearest edge of the air intake to the nearest edge of the contaminant source. All intakes must be 6 ft. above landscaped grade including soil, lawn, shrubs, or any plant life within 1.5 ft. horizontally of intake.
    4. Electric ignition for gas-fired equipment. Standing pilot lights in gas-fired equipment are prohibited. All gas-fired equipment shall utilize electric ignitions to light gas burners.
    5. All air conditioning equipment provided under this project shall meet or exceed mechanical equipment efficiency requirements outlined by the IECC Energy Code and Advanced Buildings-Benchmark Criteria. Refer to LEED Version 4, Appendix A for efficiency values. If mechanical equipment efficiencies specifically listed on the drawings are higher than the LEED or Advanced Building Requirements, the higher efficiency equipment must be provided.

#### 1.5 RELATED WORK UNDER OTHER SECTIONS

- A. The following work is included in other sections. Coordinate the work of this section as required per those sections.

- 
- B. Cutting beyond the requirements as stated herein, and patching of all openings regardless of size, is specified in the respective Sections of the trade responsible for furnishing and installing similar new materials.
  - C. For temporary controls refer to SECTION 015000 – TEMPORARY FACILITIES AND CONTROLS. If Owner authorizes use of the permanent HVAC system for temporary use during construction, provide temporary controls to adequately control the unit and not void the warranty. Coordinate extent of temporary controls with Construction Manager. Use of the new equipment for temporary heat/cooling will not start product warranty until substantial completion is achieved. Clean unit, strainers, ductwork and change filters prior to using equipment for building occupancy by the owner.
  - D. For flashing of vents/pipes through roof/walls and setting of roof curbs and flashing and waterproofing of such, refer to Section DIVISION 07 – THERMAL AND MOISTURE PROTECTION.
  - E. For power wiring of mechanical equipment refer to Section 260010.
  - F. For excavation and backfill of below grade mechanical and related systems refer to DIVISION 31 – EARTHWORK.
  - G. For structural steel refer to SECTION 051200 – STRUCTURAL STEEL FRAMING.
  - H. For firestopping not called for in this Section refer to SECTION 078400 – FIRESTOPPING.
  - I. For finished painting of mechanical systems not called for in this Section refer to SECTION 099000 – PAINTING AND COATING.
  - J. For Food Service Equipment refer to SECTION 114000 – FOOD SERVICE EQUIPMENT.
  - K. For interior concrete work relating to this Section refer to SECTION 033000 – CAST-IN-PLACE CONCRETE.
  - L. For exterior concrete work relating to this Section refer to SECTION 033000 – CAST-IN-PLACE CONCRETE.
  - M. Installation of hollow metal doors and frames refer to SECTION 081110.
  - N. For LEED requirements refer to Section 018110 – SUSTAINABLE DESIGN REQUIREMENTS.
  - O. For mechanical system commissioning refer to Section 01 91 13 – General Commissioning Requirements and Section 230800 Commissioning of HVAC Systems.
  - P. Change all air handling unit (RTU, HVU, MAU, UH, DCU) filters as required by Section 018119 - INDOOR AIR QUALITY REQUIREMENTS flush out procedures and adhere to IAQ Management Procedures.

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1.6 COMMISSIONING

- A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 019113 –Commissioning General Requirements and Section 230800 – Commissioning of HVAC Systems.
- B. Complete installation and startup checks and functional tests according to Section 019113 –Commissioning General Requirement, Section 230800 –Commissioning of HVAC Systems, and manufacturers written instructions.
- C. Operational Test: After HVAC system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the start-up procedure.
- D. Verify that equipment is installed and commissioned as per requirements of Section 019113, Section 230800, and manufacturers written instructions/requirements.

1.7 CODES, ORDINANCES, AND PERMITS

- A. Perform all work in accordance with the requirements of Framingham Building Department, State of Massachusetts Building Code, latest Edition, and applicable State and Federal Laws. Give all requisite notices, file all requisite plans, and obtain all permits required to perform HVAC Work.
- B. Permits: Be responsible for filing documents, and securing of inspection and approvals. Pay all local connection and permit fees. Costs related to temporary service, refer to Section 015000. Refer to AIA 201 General Conditions.
- C. All HVAC equipment shall be installed to meet all State, Local and Federal sound ordinances.

1.8 QUALITY ASSURANCE

- A. Codes and Standards:
  - 1. HI Compliance: Design, manufacture, and install HVAC pumps in accordance with HI Hydraulic Institute Standards".
  - 2. UL Compliance: Design, manufacture, and install HVAC pumps in accordance with UL 779 "Motor Operated Water Pumps".
  - 3. ANSI Standards: Comply with ANSI A13.1 for pipe, valve, and equipment identification.
  - 4. I=B=R Compliance: Provide boilers that have been tested and rated in accordance with Institute of Boiler and Radiator Manufacturers (I=B=R) "Testing and Rating Standard for Cast Iron and Steel Heating Boiler", and bear I=B=R emblem on nameplate affixed to boiler.
  - 5. NFPA Compliance: Install boilers in accordance with NFPA Standard 54.
  - 6. ASME Compliance: Construct boilers in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".
  - 7. UL and NEMA Compliance: Provide boiler ancillary electrical components and safety control devices, which have been listed and labeled UL, and comply with NEMA Standards.

- 
8. FM Compliance: Provide control devices and control sequences in accordance with requirements of Factory Mutual System (FM).
  9. IRI Compliance: Provided control devices and control sequences in accordance with requirements of Industrial Risk Insurance (IRI).
  10. AMCA Compliance: Test and rate air handling units in accordance with AMCA standards.
  11. AGA Compliance: Provide gas controls and devices in accordance with American Gas Associates.
  12. ARI Compliance: Test and rate air handling units in accordance with ARI 430 "Standard for Central-Station Air Handling Units", display certification symbol on units of certified models.
  13. ASHRAE Compliance: Construct and install refrigerant coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
  14. NFPA Compliance: Provide air handling unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".
  15. UL and NEMA Compliance: Provide electrical components required as part of air handling units, which have been listed and labeled by UL and comply with NEMA standards.
  16. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of air handling units.
  17. LEED: Install all HVAC systems in accordance with all current requirements.
- B. MSS Standard Practices: Comply with the following standards for valves:
1. MSS SP-45: Bypass and Drain Connection Standard
  2. MSS SP-67: Butterfly Valves
  3. MSS SP-70: Cast Iron Gate Valves, Flanged and Threaded Ends
  4. MSS SP-71: Cast Iron Swing Check Valves, Flanged
  5. MSS SP-72: Ball Valves with Flanged or Butt-Welding Ends for General Service
  6. MSS SP-78: Cast Iron Plug Valves, Flanged and Threaded Ends
  7. MSS SP-80: Bronze Gate, Globe Angle and Check Valves
  8. MSS SP-84: Steel Valves - Socket Welding and Threaded Ends
  9. MSS SP-85: Cast Iron Globe and Angle Valves, Flanged with Threaded Ends
  10. MSS SP-92: MSS Valve User Guide
- C. Automatic Temperature Control Contractor Qualifications: Branch Factory Owned Authorized dealers specializing in manufacturing and installation of control systems for not less than 5 years.
1. Codes and Standards:
    - a. Electrical Standards: Provide electrical components of control systems which have been UL-listed and labeled, and comply with NEMA standards.

- 
- b. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

#### 1.9 HAZARDOUS MATERIALS

- A. The HVAC Contractor shall be responsible for removing and legally disposing of any and all hazardous waste associated with HVAC systems, including but not limited to:
  - 1. All chemical treatment used in flushing out HVAC piping systems.
  - 2. Un-used excess material such as adhesives used in ductwork and piping installations.
  - 3. Refrigerant in all AC systems.
  - 4. Glycol in Heating and Cooling Systems.
  - 5. Items specifically noted on drawings.

#### 1.10 DISCREPANCIES IN DOCUMENTS

- A. Where Drawings or Specifications conflict or are unclear, advise Architect in writing before Award of Contract. Otherwise, Architect's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted.
- B. Where Drawings or Specifications do not coincide with manufacturers recommendations, or with applicable codes and standards, alert Architect in writing before installation.
- C. If the required material, installation and work can be interpreted differently from drawing to drawing, or between drawings and specs, the HVAC Subcontractor shall provide that material, installation and work which is of the more stringent.
- D. It is the intent of these contract documents to have the contractor provide systems and components that are fully complete and operational and fully suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely quantify and/or describe a certain component or subsystem, or the routing of a system. In cases such as this, where the contractor has failed to notify the Architect of the situation in accordance with Paragraph (A) above, the contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner and per local and state codes.

#### 1.11 CONTRACT DRAWINGS

- A. All work shown on the drawings is intended to be approximately correct to scale, but shall be taken in a sense as diagrammatic. Sizes of ductwork and pipes and general method of running them are shown, but it is not intended to show every offset and fitting. To carry out the true intent and purpose of the plans, furnish all necessary parts to make complete working systems ready for use.
- B. The HVAC Drawings and Specifications are intended to supplement each other so that any details shown on the Drawings and not mentioned in the Specifications, or vice-versa, shall be executed the same as if mentioned in the Specifications and shown on the Drawings.

- C. Refer to the Architectural, Structural, Mechanical, Plumbing, Fire Protection and Electrical Drawings which indicate the construction in which this work shall be installed. Locations shown on the plans shall be checked against the general and detailed Drawings of the construction documents. All measurements must be taken at the building/field.

#### 1.12 COORDINATION DRAWINGS

- A. Coordination requirements specific to the Work of this Section include the following:
  - 1. Before materials are purchased or work is begun, the respective Subcontractor shall prepare and submit to the Architect Coordination Drawings showing the size, elevation and location of his equipment, fixtures, ductwork, conduit, and piping lines relevant to the complete system. He shall ensure that these drawings are compatible and correctly annotated and cross-referenced at their interfaces.
  - 2. Coordination drawings are for the Contractor's and the Architect's use during construction and shall not be construed as replacing any shop or record drawings required elsewhere in the Contract Drawings.
  - 3. All coordination drawings shall be prepared in a large enough scale to accurately identify work of each trade and in addition to each sub-contractors systems, shall also show architectural floor plan, reflected ceiling plan, and structural framing with grid identification.
  - 4. The coordination drawing shall be prepared in AutoDesk Revit (2019 or later) and shall be started by the sheet metal sub-contractor and after applying all ductwork, the drawing shall be submitted for ductwork approval by the engineer. After approval, the drawing shall be circulated to the remaining sub-contractors for application of their work.
  - 5. During coordination drawing preparation the sub-contractors shall meet periodically to discuss overall coordination of all sub systems, and shall adjust their systems accordingly. When all drawings are complete the general contractor shall submit to the architect and engineers for review.
  - 6. Areas of conflict that cannot be resolved between the sub-contractor must be flagged on the drawings with adequate information to assist the architect and engineer in resolving noted issues.
  - 7. Cost for additional time to redraw areas in conflict will be completed at no cost to the owner or project.
- B. Refer to Section 013100 – PROJECT MANAGEMENT AND COORDINATION of these Contract Documents for general requirements and additional procedures relative to the preparation of Coordination Drawings.

#### 1.13 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance as well as code required clearances. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing and provide code required clearances.
- B. Extend all grease fittings to an accessible location.

1.14 ROUGH IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Costs associated with modifications to systems due to lack of field coordination with other trades and building components shall be borne by this contractor.

1.15 PHASING

- A. The mechanical subcontractor shall construct the subject project in phases as directed by the Architect to suit the project progress schedule, as well as the completion date of the project.
- B. For additional information related to phasing, review the General Conditions and Supplementary Conditions and the Architectural drawings.

1.16 NOTIFICATION OF RELATED TRADES

- A. Notify all other trades responsible for installing chases, inserts, sleeves, anchors, louvers when ready for such installation and for final checking immediately before concrete is placed. Cooperate with such trades to obtain proper installation.
- B. Leave openings in walls for pipes, and ducts for mechanical and electrical work as shown on drawings or required by layout of mechanical or electrical systems.

1.17 MECHANICAL INSTALLATIONS

- A. Coordinate mechanical equipment and materials installation with other building components before installing.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building. Costs associated with modifications to systems due to lack of field coordination with other trades and building components shall be borne by this contractor.
- F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
- G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
- H. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

- I. Coordinate connection of mechanical system with overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

#### 1.18 CUTTING AND PATCHING

- A. Penetrations through construction as required for the work of this Section:
  1. Coring: Perform all coring for required work.
  2. Notify Masonry Sub-Contractor of exact locations and sizes for openings required in masonry, to be executed under Section 042000 – UNIT MASONRY, utilizing lintels furnished per Section 055000 – METAL FABRICATIONS.
  3. Cut openings in new non-masonry construction where required for penetrations. All cutting shall conform to the requirements of Section 017329 – CUTTING AND PATCHING.
- B. Patching at penetrations through construction as required for the Work of this Section:
  1. Notify Masonry Sub-Contractor when work is complete at penetrations through masonry construction, and ready for patching under Section 042000 – UNIT MASONRY.
  2. Notify appropriate Sub-Contractors when work is complete at penetrations through non-masonry construction, and ready for patching under Sections in Division 09 - FINISHES.
- C. Throughout the performance of the cutting and coring work, ensure that the structural integrity of the existing walls, floors, overhead structure, and other structural components, which are to remain, is maintained until permanent work is installed. Prior to any coring or cutting verify all locations of same with the General Contractor. All cutting and coring is to be performed in accordance with approved coordination drawings. All cutting or coring of structural must receive approval of the Architect prior to proceeding.
- D. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.
- E. Patching of surfaces shall be by the trade responsible for the surface penetrated.
- F. Refer to related architectural sections including Section 013100 for additional reference.

#### 1.19 SUBMITTALS

- A. General: Refer to Section 013300 – SUBMITTAL PROCEDURES for general requirements for submittal of product data, shop drawings and other materials for review by the Architect and their Consultants. The following paragraphs supplement the requirements of Section 013300.
- B. Submittal of Shop Drawings, product data, and samples will be accepted only when submitted by the General Contractor. Data submitted by Sub-contractors and material suppliers directly to the Architect/Engineer will not be processed.



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- C. Submittal requirements specific to the Work of this Section include the following:
1. Valves
  2. Meters and Gages
  3. Hangers and Attachments
  4. Mechanical Identification
  5. Mechanical Insulation
  6. Hydronic Piping and Accessories
  7. Water/Chemical Treatment
  8. Glycol Feeders
  9. Refrigeration Piping
  10. Boilers
  11. Air Cooled Chillers
  12. Pumps and Accessories
  13. Terminal Heating Units (HW & Elec)
  14. Ductless Cooling Unit Systems
  15. Power and Gravity Ventilators
  16. Metal Ductwork
  17. Ductwork Accessories
  18. Duct and Piping Pressure Testing Reports
  19. Air Outlets and Inlets
  20. Sound Attenuators and Sound Lining
  21. Condensate Discharge Pumps
  22. Automatic Temperature Controls
  23. Testing, Adjusting, Balancing, and Commissioning
- D. If a Shop Drawing is not accepted after two submissions, a third submission from the same manufacturer will not be considered.
- E. Check Shop Drawings and other submittals to assure compliance with contract documents before submittal to A/E.
- F. Review of Shop Drawings is final and no further changes shall be considered without written application. Shop Drawings review does not apply to quantities, nor relieve the HVAC Subcontractor of his responsibility for furnishing materials or performing his work in full compliance with these Contract Drawings and Specifications. Review of these shop drawings shall not be considered a guarantee of the measurements of this building or the conditions encountered.

#### 1.20 SUBSTITUTIONS

- A. Refer to, Section 012500 – SUBSTITUTION PROCEDURES for requirements in requesting substitutions. The following paragraphs supplement the requirements of Section 012500

- B. If materials or equipment are substituted for basis of design specified items that alter the systems shown or its physical characteristics, or which have different operating characteristics, clearly note the alterations or difference and call it to the attention of the Architect/Engineer. Contractor shall be responsible for coordinating dimensional fit of equipment that varies from basis of design equipment. Under no circumstances shall substitutions be made unless material or equipment has been successfully operated for at least three consecutive years.
- C. Any modifications to the design, as a result of approving a substitution from the basis of design equipment, shall be the responsibility of the HVAC Subcontractor. Any additional cost to the HVAC Subcontractor or any other contractor, directly or indirectly, as a result of such substitutions, shall be the responsibility of the HVAC Subcontractor.

#### 1.21 PRODUCT LISTING

- A. Prepare listing of major mechanical equipment and materials for the project.
- B. Provide all necessary information.
- C. Submit to the A/E through the General Contractor, within 20 days of signing contract, this listing indicating all equipment and manufacturers, as a part of the submittal requirement. If the product list is not submitted, it will be the responsibility of the sub-contractor to submit one of the three named equal manufacturers.
- D. When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.
- E. Provide products, which are compatible within systems and other connected items.

#### 1.22 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, mode, number, serial number, capacity, operating, and power characteristics labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

#### 1.23 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section General Conditions for delivery, storage, and handling of equipment. The following paragraphs supplement the requirements of Section General Conditions.
- B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

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- C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
  - D. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.
  - E. All ductwork stored on site or off site shall have its ends sealed to prevent dust and debris from entering the ductwork.

#### 1.24 RECORD DOCUMENTS

- A. General: Refer to Section 017839 - PROJECT RECORD DOCUMENTS, for general requirements for maintaining as-built drawings and submitting final reproducible record documents. The following paragraphs supplement the above.
- B. Provide Record Drawings for the Work of this Section and include the following: Provide electronic AutoCAD drawings and hard copy to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column line; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located. Also provide ATC Drawings showing As-Built conditions, modified sequences, field changes and any additional items added through change orders, RFI's, or ASI's. Also, provide control wiring diagram overlaid on Architect floor plans to show actual control wiring routing and controller locations.
- C. Refer to Section 017700 – CLOSEOUT PROCEDURES for additional requirements.

#### 1.25 OPERATION AND MAINTENANCE DATA

- A. General: Refer to Section 017700 – CLOSEOUT PROCEDURES for general requirements for submittal of operations and maintenance manuals, training of personnel and related closeout procedures. The following paragraphs supplement the requirements of Section 017700.
- B. In addition to the information required by Section 017700 for maintenance data, Closeout procedures specific to the Work of this Section include the following:
  - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
  - 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and user summer and winter operating instructions.
  - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  - 4. Servicing instructions and lubrication charts and schedules.

5. Provide start-up reports for all major HVAC systems and equipment, including but not limited to, boilers, chiller, all air handling equipment, ductless cooling unit systems, pumps and fans.
6. Provide DVD recording of operation and maintenance training sessions and include as part of Operation and Maintenance Manual submittal. Provide indexed table of contents for DVD recording.
7. Cooperate with Commissioning agent as required to complete system and equipment start-up reports and testing. Refer to Section 019113 – GENERAL COMMISSIONING REQUIREMENTS and Section 230800 – COMMISSIONING OF HVAC SYSTEMS.
8. ATC Drawings/submittal of As-Built conditions.

#### 1.26 WARRANTIES

- A. The subcontractor shall provide a one year minimum warrantee on all product (unless otherwise stated in the product specification for a specific product) and labor for work under this section. Refer to general conditions for additional warranty requirements.
- B. Refer to Section General Conditions and Section 017700 - CLOSEOUT PROCEDURES for additional procedures and submittal requirements for warranties.
- C. In addition to the one year warranty period against component and/or workmanship defects, the 40 hours of training and the 80 hours of additional programming as it relates to the control system and as indicated in section 230000 paragraph 2.30 & 3.32, the ATC contractor shall provide a seasonal site visit to confirm, verify and modify as required the sequence and/or programming of each piece of equipment to ensure the system is functioning as required and per the sequence of operations. The ATC contractor shall provide 16 labor hours per season (four times within a year, total of 64 hours). During each visit they shall, for each piece of equipment confirm operation and functionality, modify and/or repair any control related issues and/or programming and provide training as requested by the owner. This requirement will ensure the equipment/building is operating properly and efficiently as it cycles through each season. These seasonal site visits shall begin the following season after substantial completion of the project is issued. Upon substantial completion the ATC contractor shall issue four dates to the engineer of record and owner. Signatures and time logs will be kept by both parties to ensure these visits occur.

#### 1.27 SUSTAINABLE DESIGN INTENT

- A. Comply with project requirements intended to achieve a minimum score of 50, measured and documented according to LEED Version 4. Project scores will be verified by a third party certifier.
  1. Refer to Section 018110– SUSTAINABLE DESIGN REQUIREMENTS – LEED for Schools, for material, procedure, and documentation submittal requirements.

- B. The project HVAC subcontractor shall perform all required work for the LEED credits listed under Section 018113.23 and as outlined in the LEED Reference Guide Version Four:

<b><u>Indoor Environmental Quality</u></b>		
<b>Item</b>	<b>Title/Description</b>	<b>HVAC Subcontractor Responsibility</b>
<b>IEQ P 1</b>	Design ventilation systems to ASHRAE Standard 62.1-2004: Ventilation for Acceptable Indoor Air Quality.	Install and Balance systems per Design requirements.
<b>IEQ C 3.1</b>	If the building or a portion of the building is to be occupied during construction, meet or exceed the Recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) <i>IAQ Guideline for Occupied Buildings Under Construction</i> , 1995, chapter 3.	Follow SMACNA Guidelines; coordinate with GC. ATC Contractor shall modify sequences as needed for this credit & return the sequences back to the requirements of the contract documents.
<b>IEQ C 3.2</b>	Construction management – provide ventilation	Provide unit start-up with GC to provide required flush-out. Provide required filter changes.
<b>IEQ C 3.2</b>	Construction management – post construction IAQ provide building flushout.	Provide flush-out calculation and coordinate unit start-up with GC to provide required flush-out. Provide temporary heating for areas served by air handling units which are not designed to heat 100 percent O.A. (i.e. re-circ RTUs if flushout occurs during winter heating season to maintain minimum 60°F space temp).
<b>IEQ C 5</b>	Install dedicated exhaust for pollutant source control.	Install exhaust air systems as designed.
<b>IEQ C 5</b>	Ensure that permanently installed filtration media have a Minimum Efficiency Reporting Value (MERV) of at least 13.	Provide MERV-13 filters.

<u>Indoor Environmental Quality</u>		
Item	Title/Description	HVAC Subcontractor Responsibility
IEQ C 7.1	Thermal comfort – ASHRAE 55	Install mechanical systems & control as designed.
IEQ P 3 & C 9	Ensure that all classrooms meet the acoustic standards of ANSI 12.60-2002.	Comply with Acoustical Consultant's report recommendation; install equipment meeting specified sound data. Refer to Vibration isolation specifications for additional requirements.
IEQ C 5	Install premium HVAC filtration.	Provide MERV-13 filters.
IEQ C 3.1 & 3.2	Construction management – post construction IAQ provide building flushout.	Prior to flushout, replace filters with MERV 13 filters and again after flushout

<u>Energy Efficiency</u>		
Item	Title/Description	HVAC Subcontractor Responsibility
EA P 2 & C1	<p><b>(A, B, or C). Energy Efficiency Standard:</b>            Design a school that performs significantly better than schools built to current standard practice by designing <b>25 percent or more above the ASHRAE 90.1 – 2007 standard</b> using            A) the prescriptive criteria established by the New Buildings Institute's main resource guide: <i>Benchmark: Energy Benchmark for High Performance Buildings</i>, B) the prescriptive approach outlined in the ASHRAE standards, or C) the Total Building Approach outlined in the ASHRAE standards.</p>	Provide equipment meeting or exceeding energy efficiency design requirements; submit shop drawings indicating equipment efficiencies.

<b><u>Energy Efficiency</u></b>		
<b>Item</b>	<b>Title/Description</b>	<b>HVAC Subcontractor Responsibility</b>
<b>EA P 1</b>	Provide effective and complete training and documentation on the operation and maintenance of the building systems identified in the commissioning report.	Provide Operating and Maintenance manuals for all HVAC/ATC systems and equipment. Provide owner training and video tape training sessions for all HVAC/ATC systems. Coordinate training with GC.
<b>EA C 1</b>	Demonstrate superior energy performance (25 percent-45 percent reduction).	Provide equipment meeting or exceeding energy efficiency design requirements; submit shop drawings indicating equipment efficiencies.
<b>EA C 5</b>	Install energy management system.	Install ATC/EMS system meeting design requirements and to monitor energy use.

1.28 ENERGY REBATE PROGRAM

- A. This project has been designed to incorporate equipment approved for energy rebate such as boilers, chillers, high efficiency motors, rooftop units, pumps, ductless split cooling units and Combined Heating and Power Modules. Contractor shall review Utility Company requirements prior to submitting shop drawing to ascertain that submittal meets program guidelines. All submitted equipment shall meet utility company rebate program efficiency requirements. Contractor shall furnish equipment submittals, related equipment/system pricing data and all required rebate application information, and forms to utility company.

1.29 HOISTING EQUIPMENT AND MACHINERY

- A. Unless otherwise specified, all hoisting and rigging equipment and machinery required for the proper and expeditious prosecution and progress of the Work of this Section shall be furnished, installed, operated and maintained in safe condition by each sub-contractor, as specified under Section 015000, TEMPORARY FACILITIES AND CONTROLS.

1.30 STAGING AND SCAFFOLDING

- A. Unless otherwise specified, each sub-contractor shall provide all lifts and man-lifts, and furnish, erect and maintain in safe condition, all staging and scaffolding as specified under Section 015000 Temporary Facilities and Controls, as needed for proper execution of the work of this Section. Staging and scaffolding shall be of adequate design, erected and removed by experienced stage builders having all accident prevention devices required by Federal, state and local laws.

1.31 WELDING QUALIFICATIONS

- A. Piping shall be welded in accordance with qualifications procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operations qualified by another employer may be accepted as permitted by ASME B31.1. The Owner's Representative shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Division 01.
  
- B. When open-flame or spark producing tools such as welding equipment, and the like are required in the process of executing the work, the Construction Manager shall be notified not less than twenty four hours in advance of the time that the work is to begin and the location where work is to be performed. Provide fire protective covering and maintain constant fire watch/fire detail (by the Framingham Fire Department) where work is being performed and until it is completed. This Subcontractor shall be responsible for obtaining required permit and paying all permit fees and Firewatch detail expenses.

1.32 TRADE RESPONSIBILITY FOR INTERCONNECTIONS MATRIX

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring	Notes
Smoke Detectors (Area type)	26 00 00	26 00 00	26 00 00	N/A	26 00 00	
Smoke Detectors (Duct mounted)	26 00 00	23 00 00	26 00 00	230000 (ATC)	26 00 00	
Smoke & Fire/Smoke Dampers	23 00 00	23 00 00	N/A	N/A	N/A	
Smoke & Fire/Smoke Damper Actuators	23 00 00	23 00 00	26 00 00 & 230000 (ATC)	230000 (ATC)	26 00 00	2
Fire Dampers	23 00 00	23 00 00	N/A	N/A	N/A	
VAV Boxes	23 00 00	23 00 00	26 00 00	230000 (ATC)	N/A	2
VAV Box Damper Actuator	230000 (ATC)	Box Mfr	230000 (ATC)	230000 (ATC)	N/A	2
VAV Box DDC Controller	230000 (ATC)	Box Mfr	230000 (ATC)	230000 (ATC)	N/A	2
Hydronic Control Valves	230000 (ATC)	23 00 00	N/A	230000 (ATC)	N/A	1
Hydronic Control Valve Actuator	230000 (ATC)	23 00 00 (ATC)	230000 (ATC)	230000 (ATC)	N/A	1
Sheet Metal Damper	23 00 00	23 00 00	N/A	N/A	N/A	1



Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring	Notes
Sheet Metal Damper Actuators	230000 (ATC)	23 00 00 (ATC)	230000 (ATC)	230000 (ATC)	N/A	1
Natural Gas Energy Meters	22 00 00	22 00 00	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	3
Electrical Energy Meters	26 00 00	26 00 00	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	3
Domestic Water Meters	23 00 00 (ATC)	22 00 00	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	3
HVAC Hydronic Energy Meters	23 00 00	230000 (ATC)	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	3
Airflow Measuring Stations	230000 (ATC)	230000 (ATC)	N/A	230000 (ATC)	N/A	
DDC Panels	230000 (ATC)	230000 (ATC)	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	4
VFDs at RTU & MAU	230000	230000 (ATC)	26 00 00	230000 (ATC)	N/A	
VFDs at EFs (except Kitchen EF), Pumps & AHUs	26 00 00	26 00 00	26 00 00	23 00 00 (ATC)	N/A	
VFDs at Kitchen Exhaust	Kitchen Equipment Vendor	26 00 00	26 00 00	23 00 00 (ATC)	N/A	
Elevator Hoistway Vent Damper	23 00 00	23 00 00	N/A	N/A	N/A	
Elevator Hoistway Vent Damper Actuator	230000 (ATC)	230000 (ATC)	230000 (ATC)	230000 (ATC)	26 00 00	
Boiler/DHW/Generator Breeching	22 00 00	22 00 00	N/A	N/A	N/A	
Kitchen Emergency Gas Valve	22 00 00	22 00 00	26 00 00	26 00 00	26 00 00	

**Notes:**

1. Division 23 00 00 and Division 230000 (ATC) Contractors shall fully coordinate all airflow damper and hydronic valves sizes and quantities.
2. Smoke Damper and VAV Box power wiring shall be provided by Division 26 00 00 to junction box locations shown on electrical drawings; Division 230000 (ATC) Contractor shall provide final power wiring from junction box to end device location.

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3. Division 26 00 00 Contractor shall provide all line-voltage power wiring required for meters; Division 23 00 00 (ATC) Contractor shall provide all low-voltage power wiring required for meters.
  4. Division 26 00 00 shall provide power at main DDC Panel. Division 230000 (ATC) shall provide power to all other DDC Panels.

## **PART 2 - PRODUCTS**

### **2.1 ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)**

A. Pursuant to Massachusetts General Laws Chapter 141, a Massachusetts Licensed electrician shall install all low voltage wiring required by this section.

B. General: The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. All motors for all mechanical equipment shall be NEMA premium efficiency matching the following and all motors associated with variable frequencies drives shall be inverted duty motor with Aegis bearing protection rings:

	HP	RPM	Efficiency
a.	1	1800	85.5 percent
b.	1.5	1800	86.5 percent
c.	2	1800	86.5 percent
d.	3	1800	89.5 percent
e.	5	1800	89.5 percent
f.	7.5	1800	91.0 percent
g.	10	1800	91.7 percent
h.	15	1800	93.0 percent
i.	20	1800	93.0 percent
j.	25	1800	93.6 percent
k.	30	1800	94.1 percent
l.	40	1800	94.1 percent
m.	50	1800	94.5 percent

2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
4. Temperature Rating: Rated for 40 degrees C. environment with maximum 50 degrees C temperature rise for continuous duty at full load (Class F Insulation). All ratings shall be for inverter duty applications.
5. Starting Capability: Frequency of starts as indicated by automatic control system and not less than five evenly time spaced starts per hour for manually controlled motors.

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6. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
  7. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
  8. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.
  9. Bearings:
    - a. Ball or roller bearings with inner and outer shaft seals.
    - b. Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
    - c. Designed to resist thrust loading where belt drivers or other drives produce lateral or axial thrust in motor.
    - d. For fractional horsepower, light duty motors, sleeve type bearings are permitted.
  10. Enclosure Type:
    - a. Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
    - b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
    - c. Weather protected Type I for outdoor use, Type II where not housed.
  11. Overload Protection: Built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
  12. Noise Rating: "Quiet".
  13. Efficiency: "Premium Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, Test Method B.
  14. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
  15. Provide AEGIS magnetic bearing protection ring for all inverter rated motors that are controlled by variable speed drives. The bearing protection ring shall channel harmful shaft voltages to ground to protect bearing races from pitting.
- C. Starters, Electrical Devices, And Wiring: (Provided By The HVAC Contractor For Each Packaged Piece Of HVAC Equipment Requiring Such):
1. Motor Starter Characteristics:
    - a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have NEC proper class and division.
    - b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
  2. Manual Switches shall have:
    - a. Pilot lights and extra position for multi-speed motors.
    - b. Overload Protection: Melting alloy type thermal overload relays.

3. Magnetic Starters:
  - a. Maintained contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
  - b. Trip-free thermal overload relays, each phase.
  - c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls Sections.
  - d. Built-in 120 volts control circuit transformer, fused from line side, where service exceeds 240 volts.
  - e. Externally operated manual reset.
  - f. Under-voltage release or protection.
4. Capacitors:
  - a. Individual unit cells.
  - b. All welded steel housing.
  - c. Each capacitor internally fused.
  - d. Non-flammable synthetic liquid impregnant.
  - e. Craft tissue insulation.
  - f. Aluminum foil electrodes.
  - g. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors one horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.
5. Disconnect Switches:
  - a. Fusible Switches: Fused, each phase; general duty; horsepower rated; non-teasible quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.
  - b. Non-fusible Switches: For equipment two horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than two horsepower, switches shall be the same as fusible type.

## 2.2 VALVES

- A. General:
  1. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
  2. Valves shall have rising stem, or rising outside screw and yoke stems; except, non-rising stem valves may be used where headroom prevents full extension of rising stems.
  3. Pressure and temperature ratings shall be as required to suit system pressures and temperatures.

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4. Unless otherwise indicated, provide valves of same size as upstream pipe size. Automatic control valves shall be sized by the ATC Contractor and shall not exceed a three PSI drop.
  5. Provide the following special operator features:
    - a. Handwheels fastened to valve stem, for valves other than quarter turn, by brass nut on a square-topped stem.
    - b. Lever handle on quarter-turn valves 6 in. and smaller, except for plug valves. Provide one wrench for every 10 plug valves, and one years' supply of recommended lubricant and sealant.
    - c. Chain-wheel operators for valves 2-1/2 in. and larger installed 72 in. or higher above finished floor elevation. Extend chains to an elevation of 5 ft. - 0 in. above finished floor elevation.
    - d. Gear drive operators on quarter-turn valves 8 in. and larger.
  6. Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
  7. Bypass and drain connections shall comply with MSS SP-45.
  8. End connections shall be as specified in the individual valves specifications.
    - a. Threads: Comply with ANSI B2.1.
    - b. Flanges: Comply with ANSI B16.1 for cast iron ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
  9. Solder-Joint: Comply with ANSI B16.18.
  10. Caution: Where soldered end connection are used, use solder having a melting point below 840 degrees F. for gate, globe, and check valves; below 421 degrees F. for ball valves.

B. Gate Valves:

1. Gate Valves – 2 in. and smaller: MSS SP-80; Class 150, body and union bonnet of ASTM B 62 cast bronze, threaded ends, solid disc, bronze alloy stem with less than 6 percent zinc content, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel.

MANUFACTURER	THREADED	
	NRS	RS
Crane:	x	431UB
Jenkins:	x	47CU
Lunkenheimer:	x	3151
Nibco:	T-136	T-134
Stockham:	B-130	B-120
Milwaukee:	41M	1151M

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2. Gate Valves 2-1/2 in. and larger: MSS SP-70; Class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A 126 Class B, flanged ends, and "Teflon" impregnated packing and two-piece backing gland assembly.

MANUFACTURER	OS&Y RS	NRS
Crane:	465-1/2	461
Jenkins:	651C	326C
Lunkenheimer:	1430	1428
Nibco:	F-617-0	F-619
Stockham:	G-623	G-612
Milwaukee:	F-2885-M	F-2882-M

C. Ball Valves:

1. Ball Valves 1 in. and smaller: Rated for 150 psi saturated steam pressure, 600 psi WOG pressure, 2-piece construction, bronze body conforming to ASTM B 62, standard (or regular) port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, and vinyl-covered steel handle. Provide solder ends for heating hot water service, threaded ends for heating hot water.

MANUFACTURER	THREADED ENDS	SOLDER ENDS
Milwaukee:	BA-100	BA-150
Conbraco (Apollo)	70-100	70-200
Crane:	9302	9322
Jamesbury:	21-1000TT	x
Jenkins:	900A	902A
Lunkenheimer:	AQ311	x
Nibco:	T-585	S-585
Watts:	B-6000	B-6001
Stockham:	S-216 BR-R-T	S-216 BR-R-S

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2. Ball Valves 1-1/4 in. to 2 in.: Rated for 150 psi saturated steam pressure, 600 psi WOG pressure; 3-piece construction, bronze body conforming to ASTM B 62, conventional port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, and vinyl-covered steel handle. Provide solder ends for heating hot water service, threaded ends for heating hot water.

	THREADED	SOLDER
MANUFACTURER	ENDS	ENDS
Milwaukee:	BA-300	BA-350
Conbraco Apollo):	82-100	82-200
Nibco:	T-595-Y	S-595-Y
Watts:	B-6800	B-6801
Stockham:	S-216 BR-R-T	S-216 BR-R-T

For grooved end connections use Victaulic Style 721.

D. Plug Valves

1. Plug Valves – 2 in. and smaller: 150 psi WOG, bronze body, straightaway pattern, square head, threaded ends.

MANUFACTURER

Rockwell:	214.
Lunkenheimer:	454.
Crane:	250.

2. Plug Valves - 2-1/2 in. and larger: MSS SP-78; 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.

MANUFACTURER

Rockwell:	305.
Nordstrom:	143.
Serck-Audco:	LSW-133-GG.
Homestead:	612.
Victaulic Series	377

E. Globe Valves:

1. Globe Valves – 2 in. and smaller: MSS Sp-80; Class 150, body and union bonnet of ASTM B 62 cast bronze, threaded ends, brass or replaceable composition disc, bronze alloy stem with less than 6 percent zinc content, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel.

MANUFACTURER

Jenkins:	106-B.
Lunkenheimer:	407.
Nibco:	T-235-Y.
Stockham:	B-22.

2. Globe Valves - 2-1/2 in. and larger: MSS SP-85; Class 125 iron body and bolted bonnet conforming to ASTM A 126, Class B; outside screw and yoke, bronze mounted, flanged ends, and "Teflon" impregnated packing and two-piece backing gland assembly.

MANUFACTURER	STRAIGHT BODY	ANGLE BODY
Milwaukee:	F-2981-M	x
Crane:	351	353
Jenkins:	613C	x
Lunkenheimer:	1123	x
Nibco:	F-718-B	x
Stockham:	G-512	G-515

F. Butterfly Valves:

1. Butterfly Valves - 2-1/2 in. and larger: MSS SP-67; 200 psi, cast iron body conforming to ASTM A 126, Class B. Valves shall have field replaceable EPDM sleeve, with aluminum bronze disc, stainless steel, and EPDM O-ring stem seals. Sizes two through six in. shall have lever operators with locks, and sizes eight through 24 in. shall have gear operators with position indicator. Valves on dead end service or requiring additional body strength shall be lug-wafer type, drilled and tapped.

MANUFACTURER	WAFER	
	LEVER	GEAR
Milwaukee:	x	MW-123-E
Center Line:	x	Series A
Crane:	42	x
Keystone:	100	x
Nibco:	WD-20003	WD-20003
Stockham:	LG-512-BS3E	LG-522-BS3E

MANUFACTURER	LUG	
	LEVER	GEAR
Milwaukee:	x	ML-123-E
Center Line:	x	Series LT
Crane:	44	x
Keystone:	129	x
Nibco:	LD-20003	LD-20005
Stockham:	LG-712-BS3E	LG-722-BS3E

Grooved Ends: Victaulic Series Vic 300 2-12 in. Victaulic series 709 14-24.



G. Check Valves:

1. Swing Check Valves – 2 in. and smaller: MSS SP-80; Class 150, cast bronze body and cap, conforming to ASTM B 62, horizontal swing, with a Teflon disc, and having threaded ends. Valve shall be capable of being repaired while the valve remains in the line.

MANUFACTURER

Milwaukee: 510T  
Crane: x  
Jenkins: 352C  
Lunkenheimer: 230-70  
Nibco: T-433-Y  
Stockham: B-321

For grooved connections us Victaulic Series 716, 779.

2. Swing Check Valves - 2-1/2 in. and larger: MSS SP-71; Class 125 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line.

MANUFACTURER	CLASS 125	CLASS 175
Milwaukee:	F-2974-M	x
Crane:	373	375
Jenkins:	624C	477
Lunkenheimer:	1790	x
Nibco:	F-918B	x
Stockham:	G-931	G-940
Victaulic Series	716, 779.	

3. Wafer Check Valves - (Non-Slam): Class 250, cast iron body, replaceable lapped bronze seat, lapped and balanced twin bronze flappers and stainless steel trim. Valve shall be designed to open and close at approximately one foot differential pressure. Twin flappers shall be loaded with a stainless steel torsion spring to minimize flapper drag and assure even non-slam checking action.

MANUFACTURER

Milwaukee: 1400-2C  
Center Line: CLC  
Metraflex: Chexx  
Mission: 12HMP  
Stockham: WG970

For grooved connection use Victaulic Series 716 and 779.

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4. Lift Check Valves – 2 in. and smaller: Class 125, cast bronze body and cap conforming to ASTM B 62, horizontal, lift type valve, bronze disc and threaded ends. Valve shall be capable of being refitted and ground while the valve remains in the line.

MANUFACTURER	HORIZONTAL
Milwaukee:	544
Hammond:	901
Jenkins:	117C
Lunkenheimer:	2142

H. Manual Flow Control Valves – Multi-Turn:

1. Manual Flow Control devices shall be NEXUS Ultra MB Multi-Turn or equal balancing type accurate to at least  $\pm 5\%$ .
2. MFCV 1½” and smaller shall be forged brass Y-pattern globe style and valves 2” – 2½” shall be a cast brass Y- pattern globe style with integrated ball valve and integral union, (2) pressure/temperature test ports, visual turns indicator, locking handle tag, blowout proof stem with dual FKM o-ring seals, interchangeable union end with FKM o-ring seal, hard chrome plated ball with Teflon™ seats, and rated at 600 PSI WOG, 325 degrees F. Valves shall be available with NPT, SWT, PRESS or PUSH connections. Note: If P/T ports are not closed to the system a secondary shutoff shall be supplied by manufacturer.
3. Valve shall carry a LIFETIME product warranty.
4. MANUFACTURER  
Milwaukee  
Stockham  
Nibco  
Or Equal

I. Coil Pak – Manual Flow Control: Contractor shall provide and install manual flow control coil piping packages at all locations as detailed in the construction documents

1. Coil Paks shall be designed for a minimum 600 PSIG WOG working pressure for sizes ½” through 2½” and up to 325 degrees F.
2. Each Coil Pak is to include an UltraMB™ or equal combination manual flow control valve, dual isolation valve, and integral union with (2) pressure & temperature test plugs; UltraY™ combination y-strainer, isolation valve, blow down / drain valve, and union with (1) pressure and temperature test plug; UltraU™ accessory port union with (1) manual air vent and (1) pressure and temperature test plug.
3. Each Coil Pak shall be “Bagged & Tagged” for easy identification and storage.
4. Extended pressure and temperature test plugs, manual air vents and handles shall be available. Extended handles shall not break the vapor barrier when operated.

5. MANUFACTURER

Milwaukee  
Stockham  
Nibco  
Or equal

2.3 METERS AND GAGES

A. Glass Thermometers

1. General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
2. Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, nine in. long.
3. Adjustable Joint: Die cast aluminum, finished to match case, 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.
4. Tube and Capillary: Magnifying lens, one percent scale range accuracy, shock mounted.
5. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
6. Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.
7. Range: Conform to the following:
  - a. Hot Water: 30 degrees – 240 degrees F. with five degrees F. scale.
8. Manufacturer: Subject to compliance with requirements, provide glass thermometers of one of the following:
  - a. Ernst Gage Co.
  - b. Marshalltown Instruments, Inc.
  - c. Terice (H.O.) Co.
  - d. Weis Instruments, Inc.
  - e. Or Equal.

B. Thermometer Wells

1. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide two in. extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.
2. Manufacturer: Subject to compliance with requirements, provide glass thermometers of one of the following:
  - a. Ernst Gage Co.
  - b. Marshalltown Instruments, Inc.
  - c. Terice (H.O.) Co.
  - d. Weis Instruments, Inc.
  - e. Or Equal.

C. Pressure Gages

1. General: Provide pressure gages of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
2. Type: General use, one percent accuracy, ANSI B40.1 grade A, phosphor bronze bourdon type, bottom connection.
3. Case: Drawn steel or brass, glass lens, 4-1/2 in. diameter.
4. Connector: Brass with 1/4 in. male NPT. Provide protective siphon when used for steam service.
5. Scale: White coated aluminum, with permanently etched markings.
6. Range: Conform to the following:
  - a. Water: 0 - 100 psi.  
50 - 300 psi.
7. Manufacturer: Subject to compliance with requirements, provide pressure gages of one of the following:
  - a. Ametek/U.S. Gauge.
  - b. Marsh Instrument Co., Unit of General Signal.
  - c. Marshalltown Instruments, Inc.
  - d. Terice (H.O.) Co.
  - e. Weiss Instruments, Inc.
  - f. Or Equal.

D. Pressure Gage Cocks

1. General: Provide pressure gage cocks between pressure gages and gage tees on piping systems. Construct gage cock of brass with 1/4 in. female NPT on each end, and "T" handle brass plug.
2. Siphon: 1/4 in. straight coil constructed of brass tubing with 1/4 in. male NPT on each end.
3. Manufacturer: Same as for pressure gages.

E. Annular Element Flow Meters And Fittings

1. General: Provide as indicated, flow metering elements constructed of brass and stainless steel, equipped with readout valves to facilitate connecting of differential pressure meter to flow meter. Equip each readout valve with integral shut-off valve designed to minimize system fluid loss during monitoring process. Provide ball type brass isolation valve. Provide calibrated nameplate with flow meter detailing its flow range through range of differential head pressures. Each element shall be of the bi-directional type having four diametrically opposed sensing ports on both upstream and downstream sides in order to ensure average velocity and static pressure. Elements shall be capable of operating at a maximum temperature of 300 degrees F. and maximum pressure of 250 psig.
2. Manufacturer: Subject to compliance with requirements, provide flow meters of one of the following:
  - a. Preso Industries Corp.
  - b. Meriam Instrument.

- c. Dieterich Standard Corp.
- d. Or Equal.

F. Calibrated Balance Valves

1. General: Provide as indicated, calibrated balance valves equipped with readout valves to facilitate connecting of differential pressure meter to balance valves. Equip each readout valve with integral EPT check valve designed to minimize system fluid loss during monitoring process. Provide calibrated nameplate to indicated degree of closure of precision machined orifice. Construct balancing valve with internal EPT O-ring seals to prevent leakage around rotating element. Provide balance valves with preformed polyurethane insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment.
2. Manufacturer: Subject to compliance with requirements, provide calibrated balance valves of one of the following:
  - a. Bell & Gossett ITT; Fluid Handling Div.
  - b. Taco, Inc.
  - c. Armstrong Pumps Inc.
  - d. Tour and Andersson
  - e. Or Equal.

2.4 HANGERS & ATTACHMENTS (Refer to SECTION 230548 for Coordination)

A. Horizontal-Piping Hangers and Supports:

1. General: Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacture for each piping service. Select size of hangers and supports to exactly fit pip size for bare piping, and to insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
  - a. Adjustable Steel Clevises Hangers: MSS Type 1.
  - b. Steel Pipe Clamps: MSS Type 4.
  - c. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
    - 1) Plate: Unguided type.
    - 2) Plate: Guided type.
    - 3) Plate: Hold-down clamp type.
  - d. Pipe Saddle Supports: MSS Type 36, including steel pipe base-support and cast-iron floor flange.
  - e. Pipe Stanchion Saddles: MSS Tube 37, including steel pip base support and cast-iron floor flange.
  - f. Adjustable Pipe Saddle Supports: MSS Type 38, including steelpipe base support and cast-iron floor flange.
  - g. Single Pipe Rolls: MSS Type 41.

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- h. Adjustable Roller Hangers: MSS Type 43.
  - i. Pipe Roll Stands: MSS Type 44.
  - j. Pipe Rolls and Plates: MSS Type 45.
  - k. Adjustable Pipe Roll Stands: MSS Type 46.
2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
- a. Carpenter and Patterson, Inc.
  - b. Corner & Lada Co., Inc.
  - c. Elcen Metal Products Co.
  - d. Fee & Mason Mfg. Co.; Div. Figgie International
  - e. ITT Grinnel Corp.
  - f. Or Equal.

B. Wall Mounted Piping Supports:

1. Metal Framing Chanel Strut

a. Area of Section = 0.555 in<sup>2</sup> (3.6 cm<sup>2</sup>)

	Axis 1-1	Axis 2-2
Moment of Inertia (I)	0.185 in <sup>4</sup> (7.7 cm <sup>4</sup> )	0.236 in <sup>4</sup> (9.8 cm <sup>4</sup> )
Section Modulus (S)	0.202 in <sup>3</sup> (3.3 cm <sup>3</sup> )	0.290 in <sup>3</sup> (4.8 cm <sup>3</sup> )
Radius of Gyration (r)	0.577 in (1.5 cm )	0.651 in (1.7 cm )

Raw steel conforms to the following ASTM specifications:

GAUGE	FINISH	ASTM NO.
12	GR & HG	A1011 SS GR 33
	PG	A653 GR 33
14	GR & HG	A1011 SS GR 33
	PG	A653 GR 33
16	GR & HG	A1011 SS GR 33
	PG	A653 GR 33
19	GR	A1008

GR = Perma-Green® III

PG = Pre-Galvanized Zinc

HG = Hot-Dipped Galvanized

2. Pipe clamps, unless noted, are punch-press made from hot-rolled, pickled and oiled steel plates, strip or coil, and conform to ASTM specifications A1008, A575, A576, A635, or A36. The fitting steel also meets the physical requirements of ASTM A1011 SS GR 33. The pickling of the steel produces a smooth surface free from scale.

- C. Vertical-Piping Clamps:
1. General: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps, complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.
    - a. Two-Bolt Riser Clamps: MSS Type 8.
    - b. Four-Bolt Riser Clamps: MSS Type 42.
  2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
    - a. Carpenter and Patterson, Inc.
    - b. Corner & Lada Co., Inc.
    - c. Elcen Metal Products Co.
    - d. Fee & Mason Mfg. Co.; Div. Figgie International
    - e. ITT Grinnel Corp.
    - f. Or Equal.
- D. Hanger-Rod Attachments:
1. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-pipe hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.
    - a. Steel Turnbuckles: MSS Type 13.
    - b. Swivel Turnbuckles: MSS Type 15.
    - c. Malleable Iron Sockets: MSS Type 16.
  2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
    - a. Carpenter and Patterson, Inc.
    - b. Corner & Lada Co., Inc.
    - c. Elcen Metal Products Co.
    - d. Fee & Mason Mfg. Co.; Div. Figgie International
    - e. ITT Grinnel Corp.
    - f. Or Equal.

E. Building Attachments:

1. General: Except as otherwise indicate, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.
  - a. Concrete Inserts: MSS Type 18.
  - b. Top Beam C-Clamp: MSS Type 19.
  - c. Side Beam or Channel Clamps: MSS Type 20.
  - d. Center Beam Clamps: MSS Type 21.
  - e. Welded Beam Attachments: MSS Type 22.
  - f. C-Clamps: MSS Type 23.
  - g. Top Beam Clamps: MSS Type 25.
  - h. Side Beam Clamps: MSS Type 27.
  - i. Steel Beam Clamps W/Eye Nut: MSS Type 28.
  - j. Linked Steel Clamps W/Eye Nut: MSS Type 29.
  - k. Malleable Beam Clamps: MSS Type 30.
  - l. Steel Brackets: One of the following for indicated loading:
    - 1) Light Duty: MSS Type 31.
    - 2) Medium Duty: MSS Type 32.
    - 3) Heavy Duty: MSS Type 33.
  - m. Side Beam Brackets: MSS Type 34.
  - n. Plate Lugs: MSS Type 57.
  - o. Horizontal Travelers: MSS Type 58.
2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
  - a. Carpenter and Patterson, Inc.
  - b. Corner & Lada Co., Inc.
  - c. Elcen Metal Products Co.
  - d. Fee & Mason Mfg. Co.; Div. Figgie International
  - e. ITT Grinnel Corp.
  - f. Or Equal.

F. Saddles and Shields:

1. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
2. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.



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3. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.
  4. Manufacturer: Subject to compliance with requirements, provide thermal hanger shields of one of the following:
    - a. Elcen Metal Products Co.
    - b. Pipe Shields, Inc.
    - c. Carpenter Patterson, Inc.
    - d. ITT Grinnel Corp.
    - e. Or Equal.
- G. Miscellaneous Materials:
1. Metal Framing: Provide products complying with NEMA STD ML 1.
  2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A 36.
  3. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
  4. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.
  5. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.
- 2.5 MECHANICAL IDENTIFICATION (Refer to SECTION 019113 and 230800 Commissioning for additional contract requirements)
- A. Plastic Pipe Markers:
1. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1
  2. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1
  3. Insulation: Furnish 1 in. thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F (52 degrees C) or greater. Cut length to extend 2 in. beyond each end of plastic pipe marker.
  4. Small Pipes: For external diameters less than 6 in. (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
    - a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
    - b. Adhesive lap joint in pipe marker overlap.
    - c. Laminated or bonded application of pipe marker to pipe (or insulation).

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- d. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than  $\frac{3}{4}$  in. wide; full circle at both ends of pipe marker, tape lapped 1-1/2 in.
- B. Application: Provide pipe labels for the following piping system:
1. Heating hot water supply and return.
  2. Refrigerant liquid and suction and hot gas bypass.
  3. Condensate drain.
  4. Chilled water supply and return.
  5. Dual temperature supply and return.
  6. Cogen Hot Water supply and return.
  7. Condenser Water supply and return.
  8. Cooling Tower blow down piping.
  9. Cooling Tower make up water piping.
- C. Valve Tags:
1. Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4 in. high letters and sequenced valve numbers 1/2 in. high, and with 5/32 in. hole for fastener.
    - a. Provide 1-1/2 in. diameter tags, except as otherwise indicated.
    - b. Provide size and shape as specified or scheduled for each piping system.
    - c. Fill tag engraving with black enamel.
  2. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- D. Where valves are located above ACT ceilings, furnish and install valve finder ceiling markers on the ceiling grid. Markers shall be a minimum of  $\frac{3}{4}$ " x 2" standard laminated plastic color-coded markers similar to Marking Services MS-900 with MS-1000 top laminate. Colors shall be different for each trade as determined by the Architect. Coordinate installation of markers with ceiling grid contractor.
- E. Valve Schedule Frames:
1. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.
- F. Plastic Equipment Markers:
1. General: Provide manufacturer's standard laminated plastic, color-coded equipment markers. Conform to the following color code:
    - a. Green: Cooling equipment and components.
    - b. Yellow: Heating equipment and components.
    - c. Yellow/Green: Combination cooling and heating equipment and components.
    - d. Blue: Equipment and components that do not meet any of the above criteria.

2. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
  - a. Equipment label "ID" from schedules.
  - b. Design capacity from schedules.
3. Size: Provide approximate 2-1/2 in. x 6 in. markers for each piece of equipment.
4. Application: Provide equipment labels for the following equipment:
  - a. Boilers
  - b. Pumps
  - c. Expansion Tanks
  - d. Rooftop Units (RTU)
  - e. Exhaust Fans
  - f. Absorbtion Chiller
  - g. Air Cooled Condensing Units
  - h. Air Seperators
  - i. Terminal Heating Units equipped with fans (ie. UH's – place label on inside cover)
  - j. Ductless Cooling Unit Systems (place label on inside cover)
  - k. Induction Units (place label on casing above ceiling)
  - l. Cogeneration Equipment
  - m. Cooling Tower
  - n. Gylcol Feeders
  - o. Chemical Feeders
  - p. Coupon Racks
  - q. Heat Exchangers
  - r. Variable Air Volume

G. Ductwork Labels:

1. Provide painted stencils or standard laminated plastic, color coded labels in accordance with ANSI for the following systems:
  - a. Supply Ductwork
  - b. Return Ductwork
  - c. Exhaust Ductwork
  - d. Hazardous Exhaust
  - e. Outside Air Ductwork
  - f. Grease Ductwork

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## 2.6 MECHANICAL INSULATION

### A. Piping Insulation Materials:

#### 1. Glass Wool Piping Insulation:

##### a. Manufacturers:

- 1) Knauf Insulation; Earthwool 1000° Pipe Insulation with ECOSE Technology
- 2) Knauf Insulation; Earthwool Redi-Klad 1000° Pipe Insulation with ECOSE Technology
- 3) Or similar as manufactured by Johns Manville, Manson, or Owens Corning

a) UL/ULC Classified per UL 723 or FHC 25/50 per ASTM E 84; EPD Certified by UL Environment; Living Building Challenge – Declare Red List Free for unjacketed Earthwool Pipe and composite Redi-Klad Pipe; meeting ASTM C 547, Type IV (1000° F.) or Type I (850° F.) ; ASTM C 585; ASTM C 411 and ASTM C 795; Verified to be formaldehyde free by UL Environment.

b. Vapor Retarder Jacket: ASJ+/SSL+ conforming to ASTM C 1136 Type I,II, III, IV, &VIII secured with self-sealing longitudinal laps and matching butt strips.

c. Redi-Klad Jacket: VentureClad 5-ply weather and abuse resistant with self-sealing lap. Zero permeability per ASTM E 96-05; puncture resistance 35.4 kg (189.3 N) per ASTM D 1000; tear strength 4.3 lb (19.4 N) per ASTM D 624; thickness 14.5 mils (0.0145"); tensile strength 68 lb/inch width [306 N (32 kg)/25 mm]

#### 2. Flexible Unicellular Piping Insulation: ASTM C 534, Type as required.

a. Type I - tubular; Type II - sheet. For use between -40 degrees F and 200 degrees F.

3. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations.

4. Encase straight pipe insulation, where exposed in occupied areas, using Redi-Klad Pipe Insulation or cover "standard" insulation with one piece 20-mil thick PVC Jacketing. Fasten and seal as per manufacturer's recommendations.

5. Encase exterior piping insulation using Redi-Klad Pipe Insulation or cover "standard" insulation with aluminum jacket with weather-proof construction.

6. Staples, Bands, Wires and Cement: As recommended by insulation manufacturer for applications indicated.

7. Adhesives, Sealants and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

### B. Piping Insulation Application and Thickness:

#### 1. Application: Cold Piping (40 Degrees F to Ambient):

##### a. Insulate the following cold HVAC piping systems:

- 1) HVAC make-up water piping.
- 2) Chilled water supply and return piping
- 3) Air conditioner condensate drain piping.

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- 4) Refrigerant liquid and suction piping.
  - b. Insulate HVAC cold water piping systems specified above with the following type and thickness of insulation:
    - 1) Fiberglass: 1-1/2 in. thick for all pipe sizes.
  2. Application: Hot Temp HVAC Piping (to 200 Degrees F)
    - a. Insulate the following hot HVAC piping systems
      - 1) HVAC Heating hot water supply and return piping.
      - 2) Hot gas refrigerant piping.
    - b. Insulate each piping system specified above with the following type and thickness of insulation:
      - 1) Fiberglass: 1-1/2 in. thick for pipe sizes up to and including 1 1/4 in, 2 in. thick for all 1 1/2 in. pipe and larger.
      - 2) Flexible Unicellular: (Refrigerant piping only) 1 in. thick.
  3. Insulation of Piping Exposed to Weather: Protect outdoor insulation from weather by installing outdoor protective finish aluminum jacketing installed as recommended by the manufacturer. Insulation thickness shall be increased by one inch versus specified pipe insulation thickness.
- C. Ductwork Insulation Materials:
1. Glass Wool Manufacturers:
    - a. Knauf Insulation
    - b. Or similar as manufactured by CertainTeed, Johns Manville, Manson or Owens Corning
  2. Rigid Glass Wool Ductwork Insulation (R-12): UL/ULC Classified unfaced, ASJ+, ASJ and FSK; FHC 25/50 per ASTM E 84 for PSK only; meeting ASTM C 612, Type IA and IB; rigid. Verified to be formaldehyde free by UL Environment, Living Building Challenge – Declare Red List Free.
  3. Flexible Glass Wool Ductwork Insulation (R-6): UL/ULC Classified; meeting ASTM C 553 Types I, II and III; ASTM C 1136 Type II and ASTM C 1290. UL GREENGUARD Gold Certified; Verified to be formaldehyde free by UL Environment; does not contain polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE or Deca-BDE; Certified to meet all requirements of EUCEB. Flexible, limited combustible.
  4. Jackets for Ductwork Insulation: ASTM C 1136 Type II, with vapor barrier.
  5. Ductwork Insulation Accessories: Provide staples, bands, wire, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
  6. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.
- D. Ductwork Insulation Application and Thickness:
1. Application: Ventilation and AC System Ductwork:
    - a. Insulate the following ductwork:
      - 1) Outdoor air and make up air ductwork.

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- 2) HVAC supply ductwork between HVAC unit discharge and room terminal outlet.
  - 3) Insulate neck and bells of supply diffusers.
  - 4) HVAC return ductwork between room terminal inlet and HVAC unit inlet.
  - 5) HVAC plenums and unit housing not pre-insulated at factory or lined.
  - 6) Exhaust ductwork between in-line exhaust fan and point of exit in building.
  - 7) Combustion air ductwork associated with boilers.
- b. Insulate each ductwork system specified above with the following type and thickness of insulation:
- 1) Rigid Fiberglass: In machine rooms, fan rooms, and mechanical spaces insulate all supply air, return air and outside air ductwork with 3 in. thick rigid (minimum R-12). All exposed supply, return and outdoor air ductwork in occupied areas shall be insulated internally with same thickness and material.
  - 2) Flexible Fiberglass: 2 in. thick (minimum R-6)
  - 3) All outside air and make up air ductwork shall be 3 in. rigid (R-12)
  - 4) All exterior ductwork insulation shall be 3" rigid (minimum R-13) and shall be covered with weather and ultraviolet resistant duct insulation wrap as manufactured by Polyguard Alumaguard All-Weather Cool Wrap, FlexClad Ideal Seal 777, or equal.
2. Equipment Insulation Materials:
- a. Rigid Glass Wool Equipment Insulation (R-9.1): UL/ULC Classified; unfaced, ASJ+, ASJ and FSK; FHC 25/50 for PSK only; meeting ASTM C 612, Type IA and IB : rigid. Verified by UL Environment to be formaldehyde free, Living Building Challenge – Declare Red List Free.
  - b. Flexible Glass Wool Equipment Insulation (R-5): UL/ULC Classified; meeting ASTM C 553 Types I, II and III; ASTM C 1136 Type II and ASTM C 1290. UL GREENGUARD Gold Certified; Verified to be formaldehyde free by UL Environment; does not contain polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE or Deca-BDE; Certified to meet all requirements of EUCEB. Flexible, limited combustible.
  - c. Flexible Unicellular Equipment Insulation: ASTM C 534, Type as required.
    - 1) TYPE I - TUBULAR.
    - 2) TYPE II - SHEET.
  - d. Jacketing material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.
  - e. Equipment Insulation Compounds; Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

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- f. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.
- E. Equipment Insulation Application and Thickness:
- 1. Application: Cold Equipment (Below Space Temperature):
    - a. Insulate the following cold equipment:
      - 1) Drip pan under chilled equipment.
      - 2) Expansion Tank
      - 3) Chilled Water pumps
      - 4) Air Separator
    - b. Insulate each item of equipment specified above with the following type and thickness of insulation:
      - 1) Fiberglass: 2 in. thick for cold surfaces above 35 degrees F and 3 in. thick for surfaces 35 degrees F and lower.
      - 2) Flexible Unicellular: 1.5 in. thick.
  - 2. Application: Hot Equipment
    - a. Insulate the following:
      - 1) Expansion Tank
      - 2) Air Separator
      - 3) Radiant Panels
    - b. Insulate each item of equipment specified above with the following type and thickness of insulation:
      - 1) Fiberglass 2 in. thick.
      - 2) Flexible unicellular 1.0 thick (radiant panels only, coordinate with radiant panel manufacturer).

## 2.7 GREASE DUCT INSULATION

### A. MATERIAL

- 1. Thermal Material: 2192 degrees F rated core blanket, manufactured from patented bio-soluble Superwool chemistry (Calcium Magnesium Silicate).
  - a. Product: FireMaster FastWrap XL or Pyroscat Duct Wrap XL as manufactured by Thermal Ceramics.
  - b. Fully encapsulated thermal material in fiberglass reinforced aluminum/polypropylene scrim (FSP).
    - 1) Encapsulation FSP marked with UL Classification Mark.
    - 2) Encapsulation FSP marked with ICC-ES report number ESR 2213 or ESR 2832.
    - 3) Collars supplied in 6 in. (150 mm) wide by 25 ft.t (7620 mm) long rolls.
- 2. Product Characteristics:
  - a. Thickness: 1-1/2 in. (38 mm).
  - b. Nominal Density: 6 pcf.

- c. R-Value: 7.35 per layer of FireMaster FastWrap XL or Pyroscat Duct Wrap XL when tested in accordance with ASTM C 518 at 75 F.
- d. Flame Spread: <25 when tested in accordance with ASTM E 84.
- e. Smoke Development: <50 when tested in accordance with ASTM E 84.

B. ACCESSORY MATERIALS:

1. Glass Filament Tape: Minimum 3/4 in. (19 mm) wide - used to temporarily secure blanket until permanent attachment using steel banding and/or steel insulation pins.
2. Aluminum Foil Tape: Minimum 3 in. (76 mm) used to seal cut edges.
3. Carbon Steel or Stainless Strapping Material Minimum: 1/2 in. (13 mm) wide and 0.015 in. (.38 mm) thick
4. Steel Insulation Pins: Minimum 12-gauge, length sufficient to penetrate through duct wrap insulation.
5. Insulation Clips: Galvanized steel, minimum 1-1/2 in. (38 mm) round or square.
6. Through Penetration Firestop Sealants:
  - a. Packing Material: Remove encapsulation material from FireMaster FastWrap XL or Pyroscat Duct Wrap XL, use core blanket (white) as penetration packing material.
  - b. Firestop sealants per applicable building code report and/or laboratory design listings.
7. Grease and HVAC Duct Access Doors:
  - a. Thermal Ceramics FastDoor XL Access doors; Supplied in standard door sizes of 6 by10 in. (152 mm by 254 mm), 8 by12 in. (203 mm by 305 mm), 12 by12 in. (305 mm by 305 mm) 12 by16 in. (305 mm by 406 mm), and 20 by20 in. (508 mm by 508 mm).

2.8 HYDRONIC PIPING AND ACCESSORIES

- A. Manufacturer: Subject to compliance with requirements, provide piping system products from one of the following:
1. Grooved Mechanical Joint Pipe, Fittings and Couplings:
    - a. Victaulic Company of America.
    - b. Anvil Gruvlok
    - c. Grinnell
    - d. Or equal
  2. ProPress Copper Piping system (2" pipe and smaller):
    - a. Viega
    - b. Or equal
  3. Pump Discharge Valves (Triple-Duty Valve):
    - a. Bell & Gossett ITT; Fluid Handling Div.
    - b. Amtrol, Inc.
    - c. Armstrong Pumps, Inc.



- d. Taco, Inc.
  - e. Victaulic (Tri-Service Assembly)
  - f. Or equal
4. Safety Relief Valves:
- a. Bell & Gossett ITT; Fluid Handling Div.
  - b. Amtrol, Inc.
  - c. Spirax Sarco.
  - d. Watts Regulator Co.
  - e. Or equal
5. Pressure Reducing Valves:
- a. Bell & Gossett ITT; Fluid Handling Div.
  - b. Amtrol, Inc.
  - c. Armstrong Pumps, Inc.
  - d. Taco, Inc.
  - e. Or equal
6. Air Vents:
- a. Bell & Gossett ITT; Fluid Handling Div.
  - b. Armstrong Machine Works.
  - c. Hoffman Specialty ITT; Fluid Handling Div.
  - d. Spirax Sarco.
  - e. Or equal
7. Air Separators:
- a. Bell & Gossett ITT; Fluid Handling Div.
  - b. Amtrol, Inc.
  - c. Armstrong Pumps, Inc.
  - d. Taco, Inc.
  - e. Or equal
8. Diaphragm-Type Compression Tanks:
- a. Bell & Gossett ITT; Fluid Handling Div.
  - b. Amtrol, Inc.
  - c. Armstrong Pumps, Inc.
  - d. Or equal
9. Pump Suction Diffusers:
- a. Bell & Gossett ITT; Fluid Handling Div.
  - b. Amtrol, Inc.
  - c. Armstrong Pumps, Inc.
  - d. Taco, Inc.
  - e. Victaulic (style 731-D / W731-D)
  - f. Or equal

10. Chemical Feeder:
  - a. Dearborn USA.
  - b. Vulcan Laboratories, Subsidiary of Clow Corp.
  - c. York-Shipley, Inc.
  - d. Or equal
11. Basket Strainers:
  - a. Crane Co.
  - b. Metraflex Co.
  - c. Spirax Sarco.
  - d. Victaulic Company of America. (732/W732/730/W730)
  - e. Or equal

B. PIPE AND TUBING MATERIALS

1. Copper Tubing: ASTM grade B 88, Type L hard drawn temper copper tubing.
2. Copper Tubing: ASMT grade B 88, Type K, annealed copper tubing.
3. Steel Pipe: ASTM A-53 grade B, Schedule 40, seamless, black steel pipe, beveled ends.
4. CPVC Plastic Pipe: ASTM D 2846, Chlorinated Poly (Vinyl Chloride) (CPVC) pipe.

C. FITTINGS

1. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B2.1.
2. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B2.1.
3. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
4. Grooved Mechanical Fittings: ASTM A 106, or ASTM A 53/A53M, Type F, E or S, Grade B fabricated steel, or ASTM A 234, Grade WPB forged steel fittings with grooves or shoulders designed to accept grooved end couplings.
5. Grooved Rigid Mechanical Couplings: Consist of a two- piece ductile iron housing per ASTM A536, a synthetic rubber gasket of a central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
  - a. Rigid Couplings:
    - 1) Housings 12" and smaller cast with offsetting angled-pattern bolt pads to provide visual confirmation upon metal-to-metal pad contact with no torque requirement. Victaulic Style 107H and Style 07 or equal. Designs that permit spaces at bolt pads or require a torque per manufacturer's written installation instructions not permitted
    - 2) Housings 14" and larger cast with wedge-shaped groove profile, lead-in chamfer and flat pad design for metal-to-metal pad contact. Victaulic Style W07 or equal.

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- b. Flexible Couplings:
    - 1) Use in locations where vibration attenuation and stress relief are required. Victaulic Style 177, 77 or W77 or equal. Three flexible couplings may be used in lieu of each flexible connector for vibration attenuation. Couplings shall be placed in close proximity to the vibrating source in accordance with published guidelines.
  - c. Flange Adapters: Ductile iron housing, flat face, for use with grooved end pipe and fittings, for mating directly with ANSI Class 125, 150, and 300 flanges. Victaulic Style 741, 743 or W741 or equal.
- 6. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.
  - 7. CPVC Plastic Fittings: ASTM D 2846, Chlorinated Poly Vinyl Chloride (CPVC) socket-type fittings and solvent for solvent cemented joints.
  - 8. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125; raised ground face, bolt holes spot faced.
  - 9. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.
  - 10. Steel Flanges and Flanged Fittings: ANSI B16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:
    - a. Material Group: 1.1.
    - b. End Connections: Butt Welding.
    - c. Facings: Raised face.
  - 11. Solder Filler Metals: ASTM B 32, 50-50, Tin-Lead, for condenser water, chilled water, and make-up water and drain piping.
  - 12. Solder Filler Metals: ASTM B 32, 95-5 Tin-Antimony, for heating hot water and low pressure steam piping.
  - 13. Brazing Filler Metals: AWS A5.8.
  - 14. Gasket Material: EPDM Thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures.
  - 15. Flexible Connectors: Stainless steel bellows with woven flexible bronze wire reinforcing protective jacket; minimum 150 psig working pressure, maximum 250° F. operating temperature. Connectors shall have flanged, grooved or threaded end connections to match equipment connected; and shall be capable of 3/4" misalignment.
    - a. Three (3) flexible couplings may be used in lieu of each flexible connector for vibration attenuation. Couplings shall be placed in close proximity to the vibrating source in accordance with published guidelines.
- D. PIPE SLEEVES AND ESCUTCHEONS
- 1. General: Provide schedule 40 black steel or 18 gage galvanized pipe sleeve large enough to accept pipe along with specified pipe insulation at each point where pipe penetrates a wall or floor. Sleeve shall be large enough to allow for free movement of pipe however minimized to prevent leakage of smoke and fire during a fire emergency. For all piping exposed to view provide a chrome plated escutcheon that will surround insulation where applicable on pipe for a neat finished appearance. Where piping is concealed above ceilings no escutcheons are required.

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E. SPECIAL DUTY VALVES

1. General: General duty valves (i.e., gate, check, ball, and butterfly valves) are specified in Division 23 Section "Valves" Special duty valves are specified in this Article by their generic name; refer to the drawings for specific applications of these valves.
2. Pump Discharge Valves (Triple-Duty Valve): 175 PSIG working pressure, 300° F. maximum operating temperature, cast-iron body, bronze disc and seat, stainless steel stem and spring, and "Teflon" packing. Valves shall have flanged connections and straight or angle pattern as indicated. Features shall include non-slam check valve with spring-loaded weighted disc, and calibrated adjustment feature to permit regulation of pump discharge flow and shutoff.
  - a. In grooved installations, Tri-Service Assemblies may be used in lieu of Triple-Duty Valves. Straight pattern, (300-psi) pressure rating, combination shut-off, throttling, and non-slam check service in one unit. Victaulic Vic®-300 MasterSeal™ or equal, butterfly valve assembled with Series 779 Venturi Check valve or equal, with flow measurement capabilities and Victaulic or equal couplings (style to be determined by system requirements) for 2" through 12". Straight pattern, 230-psig pressure rating combination shut-off, throttling, and non-slam check service in one unit. Victaulic AGS-300 or equal butterfly valve assembled with Series W715 or equal check valve and Victaulic or equal couplings for 14" and larger.
3. Pressure Reducing Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment.
4. Safety Relief Valves: 125 psig working pressure and 250° F. maximum operating temperature: designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber. Select valve to suit actual system pressure and BTU capacity.
5. Combined Pressure/Temperature Relief Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment. Safety relief valve designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber; 125 psig working pressure and 250° F. maximum operating temperature. Select valve to suit actual system pressure and BTU capacity. Provide with fast fill feature for filling hydronic system.

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F. HYDRONIC SPECIALTIES:

1. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240° F. operating temperature; and having 1/4" discharge connection and 1/2" inlet connection.
2. Diaphragm-Type Compression Tanks: Size and number as indicated; construct of welded carbon steel for 125 psig working pressure, 375° F. maximum operating temperature. Separate air charge from flexible diaphragm securely sealed into tank. Provide taps for pressure gage and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 01.
3. Pump Suction Diffusers: Cast-iron or ductile iron body, with threaded connections for 2" and smaller, flanged or grooved connections for 2-1/2" and larger; 175 psig working pressure, 300° F. maximum operating temperature for flanged and 300 psig working pressure, 230F for grooved; and complete with the following features:
  - a. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
  - b. Cylinder strainer with 3/16" diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
  - c. Disposable fine mesh strainer to fit over cylinder strainer.
  - d. Permanent magnet, located in flow stream, removable for cleaning.
  - e. Adjustable foot support, designed to carry weight of suction piping.
  - f. Blowdown tapping in bottom; gage tapping in side.
4. Chemical Filter Feeder: (Provide one (1) for each piping system). Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch (89-mm) fill opening in the top, and NPS 3/4 (DN 20) bottom inlet and top side outlet. Feeder shall have a stainless steel dissolving basket that fully supports the filter bag. The filter bag shall be the 5-micron type with ring top and handle. The feeder shall have only a threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel. The filter feeder shall be similar to Neptune Model FTF-5DB.
  - a. Capacity: 5 gal. (19 L).
  - b. Working Pressure: 125 psig (860 kPa)
5. Y-Pattern Strainers: Cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2" and larger, threaded connections for 2" and smaller, bolted cover, perforated Type 304 stainless steel basket, bottom drain connections; 125 psig working pressure.
6. Basket Strainers: High tensile cast-iron body (ASTM A 126, Class B), flanged end connections, bolted cover, perforated Type 304 stainless steel basket, bottom drain connections; 125 psig working pressure.

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7. Grooved-End Strainers:
    - a. Y-Pattern: Ductile iron body ASTM A536, grooved ends for 2" and larger, coupled cover, perforated Type 304 stainless steel basket, bottom drain, 300 psig working pressure.
    - b. T-Pattern: Ductile iron body ASTM A536, grooved ends for 2" and larger, coupled or T-bolt hinged cover, perforated 304 stainless steel basket, bottom drain, up to 750 psig working pressure.
  8. Grooved-End Expansion for Steel Piping 2" and larger (Water Service):
    - a. 2" Through 6": Packless, gasketed, slip-type expansion joint with grooved end telescoping body for installation with Victaulic Style 107 or 07 rigid couplings. Provides axial end movement to 3", designed for water services up to 230°F and working pressure to 350 psi. Victaulic Style 150 Mover®.
    - b. 2" Through 24": Combination of short nipples and Victaulic Style 177 or 77 flexible couplings joined in tandem for increased expansion. Joint movement and expansion capabilities dependent on number of couplings/nipples used in the joint. Pressure rating dependent on size and style of flexible couplings used. Victaulic Style 155.
    - c. Expansion Loops: Pipe bends and loops in grooved piping systems shall consist of (8) Victaulic Style 177, 77 or W77 flexible couplings, (4) Victaulic 90° elbows, and (3) grooved end pipe spools provided in water systems to +250°F in accordance with the latest Victaulic recommendations for expansion compensation. Rigid couplings shall not be used on loop corners.
    - d. Expansion Joints: Provide pipe expansion joints at all building expansion joints. Utilize a seismic expansion fitting similar to Metra-Flex, Metra Loop Grooved ends or equal. The expansion fitting shall provide absorption in the lateral offset and angular movement.
  9. AIR and DIRT SEPARATORS - Air and dirt removal device shall be constructed of steel. It shall be designed, fabricated and stamped per ASME Section VIII Division 1 with a maximum working pressure of 125 psi at 270°F. Manufacturer shall be holder of ASME U stamp. Manufacturer to have optional 250 psi and 150 psi ASME units available. Units up to three 3-inch in size shall be provided with threaded connections as standard. Units four 4-inch and larger shall be provided with flanged system connections as standard. Inlet and outlet connections to be inline with piping system. Both inlet and outlet to be in the same horizontal and vertical planes. Each air and dirt removal device shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. The air vent shall be able to be closed to allow flushing and purging of dirt via side port without dirt passing through vent on initial system fill. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and removal of the floating impurities from the air system interface within the separator. A blow down valve shall be provided by the unit manufacturer on the bottom of each unit to allow blow down and cleaning. On units 2 ½" and smaller the valve and all of its fittings shall be 1". On units three 3" and larger the valve and all openings shall be 2".

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10. Glycol/Make-up Pump - Provide a packaged automatic glycol solution make up unit consisting of a base, polyethylene reservoir with removable lid and visible solution level scale in gallons, y-stainers, isolation valves, fill pump with a minimum capacity of 5 gpm @ 100 psi discharge, open drip proof motor, pump isolation, check and balancing valves, discharge pressure gauge, motor contactor, pressure control and necessary interconnecting piping. Pump shall be a bronze gear driven design and shall have a standard 120 volt power electrical cord and all necessary controllers and safeties. The unit shall provide alarm outputs for BMS connection via Bacnet.
  11. Flexible Expansion Loop (seismic and thermal expansion applications):
    - a. All equipment, either rigidly mounted or mounted on vibration isolators, shall be attached to the piping system using flexible loops designed for seismic movement. Flexible loops shall be capable of movement in the X, Y, and Z planes and must completely isolate the equipment from the piping.
    - b. All piping passing through building seismic joints shall contain a flexible expansion loop designed for seismic movement. Flexible loops shall be located at, or near the building seismic joint. A vertical support hanger, located within 4 pipe diameters, shall be installed on each side of the flexible loop. Each hanger to be transversely and longitudinally braced per local codes. Seismic bracing shall not pass through building seismic joint and shall not connect or tie together different sides or parts of building structure. Flexible loops shall be capable of move in the X, Y, and Z planes.
    - c. Flexible loops attached to fuel gas lines, shall be specifically manufactured for fuel gas applications and certified by the American Gas Association. Flexible loops connected to medical gas piping shall be specifically manufactured for medical gas and installed by a certified installer. Unless specified otherwise by system design engineer or governing codes, all flexible loop connections to medical gas piping shall be cleaned, installed, inspected, and tested in accordance with current NFPA-99 standards.
    - d. Flexible expansion/seismic loops shall consist of two flexible sections of hose and braid, two 90 elbows, and a 180 return assembled in such a way that the piping does not change direction, but maintains its course along a single axis. Flexible loops shall have a factory supplied, center support nut located at the bottom of the 180 return, and a drain/air release plug. Flexible loops shall impart no thrust loads to system support anchors or building structure. Flexible loops may be installed to accommodate both thermal and seismic motion. For steam service, loops must be installed with flexible legs horizontal to prevent condensate buildup. Materials of construction and end fitting type shall be consistent with pipe material and equipment/ pipe connection fittings. Movement capabilities and location, relative to seismic separation, shall be determined manufacturers recommendations.
    - e. Flexible expansion/seismic loops to be Metraloop(r) or approved equal
- G. Chilled Water Buffer Tank
1. Designed and constructed per ASME Code Section VIII, Division 1.

2. Construction: Carbon Steel with exterior red oxide primer finish.
3. Maximum Design Pressure and Temperature: 125 psi @ 375°F.
4. Flanged inlet and outlet System Connections (refer to plans for pipe sizes).
5. Registered with the National Board of Pressure Vessel Manufacturers.
6. Buffer tanks shall be factory insulated with 1 in cellular foam with vapor barrier insulation rated in accordance with NFPA 90a Fire/smoke ratings.
7. Manufacturers:
  - a. Cemline
  - b. Amtrak
  - c. Wessels
  - d. Or equal

## 2.9 REFRIGERANT PIPING

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.5 Code for refrigeration piping where applicable, base pressure rating on refrigerant piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigerant piping systems. Where more than one type of materials and products are indicated, selection is Installer's option.
- B. Material: Provide pipes and pipe fittings in accordance with the following listing:
  1. Tube Size 4-1/8 in. and smaller: Copper tube; Type ACR, hard-drawn temper; wrought-copper, solder-joint fittings; brazed joints.
- C. Soldered Joints: Solder joints using silver-lead solder, ASTM B32, Grade 96 TS.
- D. Brazed Joints: Braze joints using American Welding Society (AWS) classification BCUO-4 for brazing filler metal.
- E. Piping Specialties: Provide piping specialties complying with Division 23 "Hydronic Piping" in accordance with the following listing:
  1. Pipe escutcheons.
  2. Drip pans.
  3. Sleeves.
  4. Sleeve seals.
- F. Refrigerant Valves: Special valves required for refrigerant piping include the following types.
  1. Globe Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300 degrees F (149 degrees C) temperature rating, 500 PSI working pressure.
  2. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided piston and stainless steel spring, 250 degrees F (121 degrees C) temperature rating, 500 PSI working pressure.



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3. Manufacturer: Subject to compliance with requirements, provide globe and check valves of one of the following:
    - a. Henry Valve CO.
    - b. Parker Hannifin Corp.; Refrigeration & Air Cond. Div.
    - c. Sporlan Valve Co.
    - d. Or Equal
  4. 2-Way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, teflon valve seat, NEMA 1 solenoid enclosure, 24 volt, 60 Hz., UL-listed, ½ in. conduit adapter, 250 degrees F (121 degrees C) temperature rating, 400 PSI working pressure.
  5. Manufacturer: Subject to compliance with requirements, provide solenoid valves of one of the following:
    - a. Alco Controls Div.; Emerson Electric Co.
    - b. Automatic Switch Co.
    - c. Sporland Valve CO.
    - d. Or Equal
  6. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, 100 mesh, UL-listed, 350 PSI working pressure.
  7. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL-listed, 200 degrees F (93 degrees C) temperature rating, 500 PSI working pressure.
  8. Refrigerant Filter-Driers: Steel shell, ceramic fired desiccant core, solder connections, UL-listed, 500 PSI working pressure.
  9. Refrigerant Filter-Driers: Corrosion-resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron coverplate with steel cap screws, replaceable filter-drier core, 500 PSI working pressure.
  10. Evaporator Pressure Regulators: Provide corrosion-resistant, spring loaded, stainless steel springs, pressure operated, evaporator pressure regulator, in size and working pressure indicated, with copper connections.
  11. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL-listed.
  12. Manufacturer: Subject to compliance with requirements, provide refrigeration accessories of one of the following:
    - a. Alco Controls Div.; Emerson Electric CO.
    - b. Henry Valve CO.
    - c. Parker-Hannifin Corp.; Refrigeration & Air Conditioning Div.
    - d. Sporlan Valve Co.
    - e. Or Equal.
- G. Basic Vibration Control: Provide vibration control products as required in accordance with the following listing:
1. Isolation hangers.
  2. Riser isolators.

3. Riser support isolators.
4. Flexible pipe connectors.

2.10 HIGH EFFICIENCY, GAS-FIRED CONDENSING BOILERS (Refer to SECTION 019113 and 230800 Commissioning for additional contract requirements)

A. Manufacturers

1. This specification is based on the Array Series boilers as manufactured by Riello International Inc. Equivalent units and manufacturers must meet all performance criteria, and will be considered upon prior approval.
  - a. Riello
  - b. Buderus/Busch
  - c. Viessmann
  - d. Or equal

B. Related Documents

1. Drawings and general provisions of the Contract apply to this Section, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

C. Summary

1. This Section includes packaged, factory-fabricated and -assembled, gas-fired, stainless steel condensing boilers, trim, and accessories for generating hot water.

D. SUBMITTALS

1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
3. Source quality-control test reports.
4. Field quality-control test reports.
5. Operation and maintenance data.
6. Warranty: Special warranty specified in this Section.
7. Other Informational Submittals: Startup service reports specific to burner type as provided by manufacturer.

E. Quality Assurance

1. Manufacturer Qualifications: Provides products manufactured in ASME-certified facilities.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

4. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
5. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
6. AHRI Compliance: Boilers shall be tested and rated according to AHRI "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with AHRI emblem on a nameplate affixed to boiler.

F. Warranty

1. Warranty Period for Water-Tube Condensing Boilers:
  - a. Leakage and Materials: 10 years from date of Substantial Completion.
  - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Non-prorated for 10 years from date of Substantial Completion.

G. Manufacturer Units

1. Description: Factory-fabricated, assembled, and pressure tested, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; water supply, and condensate drain connections. Each boiler shall be assembled with required wiring and piping as a self-contained unit.
2. Heat Exchanger: Plasma welded 316L dual tube stainless steel heat exchanger and burner tube with high quality condensing heating surfaces. Each watertube shall be at least 7/8" ID. Stainless steel heat exchangers shall be inspected and tested to ASME Section IV requirements and shall bear the ASME section IV seal of approval. Only boilers employing nonferrous materials on all flue gas passes will be considered.
3. "Near condensing" copper fin designs, cast iron, cast aluminum, or secondary condensing exchangers will not be considered.
4. Pressure Vessel: Carbon steel with welded heads and tube connections, counter-flow design with low- and high-temperature returns. The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall contain a volume of water no less than:

Model	Water Volume in Gallons (Liters)
Scheduled	20.0 (75)

5. Burner:
  - a. Natural Gas, premixed burner.
  - b. The burner shall operate with a 5:1 turn down on each module;Boiler:  
SSB1000TL4 shall operate with a minimum 40:1 turndown ratio,

6. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
  - a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
    - 1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
7. Gas Train: Each boiler shall be supplied with multiple gas valves designed with negative pressure regulation and shall be capable of the following minimum turndown ratios:

Model	Turndown	Min Input in BTU/hr (kW)	Max Input in BTU/hr (kW)
SSB1000TL	10:01	102,400 (29)	1,024,000 (300)

8. Hydraulic Manifold: The Boiler(s) hydraulic manifold piping (water, gas and exhaust/ air) shall be factory installed and self-contained within the Boiler(s) outer cabinet.
9. The boiler shall have a minimum of 86 sqft/1000 MBH of effective fireside heating surface.
10. Ignition: Pilot ignition with 100 percent main-valve shutoff with electronic flame supervision.
11. High Altitude: Boiler shall operate at altitudes up to 2,000 feet above sea level without additional parts or adjustments.
12. Casing:
  - a. Jacket: Sheet metal, with snap-in or interlocking closures.
  - b. Finish: Electrostatic powder-coated protective finish.
  - c. Insulation: Minimum 10mm thick, glass fiber insulation surrounding the heat exchanger.
  - d. Combustion Chamber and Other Flue Passage Access: Full-sized front access
  - e. Access: Side panels easily removed.
13. Design Values and Capacities: Refer to Schedules

H. Trim

1. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
2. Boiler(s) shall be equipped with a multi-speed circulator pump on each module.
3. Aquastat Controllers: Operating, firing rate, and high limit.
4. Safety Relief Valve: ASME rated.
5. Low Water Cut-off: Manual reset whenever boiler water level falls below safe level.
6. Pressure and Temperature Gage: Combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

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7. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
  8. Condensate Neutralization System: Refer to Plumbing drawings and Specifications.
- I. Controls
    1. Boiler(s) shall be equipped with an integrated 7" color touch-screen controller that shall monitor and control all combustion process functions, control of the boiler water temperature to a value required by the connected components and shall display current water temperatures or fault conditions with changes in operation status.
    2. The boiler shall have multiple heating parameters designed for the most common applications with options including:
      - 0 – Heating demand (end switch / Thermostat)
      - 1 – Weather compensations with heating demand
      - 2 – Weather compensation with full outdoor temperature reset
      - 3 – Permanent heat demand
      - 4 – Analog input of setpoint
      - 5 – Analog input of Modulation Rate
    3. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections. ATC Controls are specified in Division 230000, and HVAC Control drawings.
    4. Boilers shall be provided with BACNet-IP compatible controller capable of integrating into Building Energy Management System.
  - J. Source Quality Control
    1. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- 2.11 PUMPS (P) (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)
- A. General: Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.
  - B. Frame-Mounted End Suction Pumps:
    1. General: Provide frame-mounted end suction pumps where indicated, and of capacities and having characteristics as scheduled.
    2. Type: Horizontal mount, single stage, vertical split case, flexible coupling, base mounted, designed for 175 psi working pressure.
    3. Casing: Cast iron, 125 psi ANSI flanges, tappings for gage and drain connections.
    4. Shaft: Steel with replaceable shaft sleeve.
    5. Bearing: Regreasable ball bearings.
    6. Seal: Mechanical, with carbon seal ring and ceramic seat.

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7. Motor: Open, dripproof, regreasable ball bearings under motor: Provide AEGIS magnetic bearing protection ring for all inverter rated motors that are controlled by variable speed drives. The bearing protection ring shall channel harmful shaft voltages to ground to protect bearing races from pitting.
  8. Impeller: Enclosed type, hydraulically and dynamically balanced keyed to shaft and secured with locking screw.
  9. Baseplate: Structural steel with welded cross members, and open grouting area.
  10. Coupling: Flexible, capable of absorbing torsional vibration, equipped with coupling guard.
  11. Manufacturer: Subject to compliance with requirements, provide frame-mounted end suction pumps of one of the following:
    - a. Bell & Gosset ITT; Fluid Handling Div.
    - b. Taco
    - c. Armstrong Pumps, Inc.
    - d. Or Equal.

C. Inline Pumps:

1. General: Provide single stage, canned-rotor type, in-line pumps where indicated and of capacities and having characteristics as scheduled.
2. Casing shall be constructed of EN-GJL-250 or ASTM-A 48 class 35 cast iron. The pump casing / volute shall be rated for 175psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with ANSI class 125 flanges. All casings shall be flanged connections.
3. Impeller: The impeller and shaft shall be class 304 stainless steel.
4. Bearings: The pump and motor form an integral unit without a mechanical seal. The bearings are lubricated by the pumped liquid. No petroleum lubricated bearings will be accepted.
5. Electronics: The pumps shall be able to operate as single or parallel variable speed pumps, where the speed is regulated by an on-board electronic device. The onboard electronics shall allow these pumps to run in parallel, standby or alternating modes.
6. Set-up: The commissioning and set up of the pump shall be accessed through a web interface (data exchange) and use html 1.1 web language. The pump shall provide a port for a RJ-45 cable connection.
7. Pressure control: The electronics shall provide constant pressure control ( $\delta p-c$ ), variable differential pressure control ( $\delta p-v$ ) as the factory default, proportional pressure control, constant curve duty (uncontrolled pump), rpm regulation and power limitation control.
8. Inputs/outputs: The pump electronics shall come standard with 2 external digital inputs and 1 external digital output to be available for additional mechanical room control. The integrated pump controller shall be provided with BMS communication (BacNet) for pump control and monitoring.
9. Enclosure: The wiring / electronics enclosure shall be class 2, ip44.

10. Code compliance: Pumps should meet UL 778, 1004-1, 508C, CAN/CSA C22.2 #108, #100, #107.1, EMC (89/366 EEC): EN 61000, LVD (73/23/EC): EN 60335-1, EN 60335-2-51, and Machine Safety (98/37/EC): EN ISO 12100.
11. Electronic protection: the pumps shall be electronically protected, be rated for continuous duty and have a built-in startup circuit. The pump electronics shall provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status and over temperature protection.
12. Internet link: The pump shall be capable of being monitored 24/7 via integrated internet link.
13. Ecm motor: The pump must be driven by an electrically commutated electrical motor (ECM) with permanent magnet rotor. The rotor magnets shall be time stable, non-toxic ceramic magnets (SR-FE). The electrically commutated electrical motor shall be driven by a frequency converter with an integrated PFC filter.
14. Manufacturer: subject to compliance with requirements. Provide in-line ecm pump of one of the following:
  - a. Bell & Gossett
  - b. Taco
  - c. Armstrong
  - d. Or equal
15. All pumps located outdoors (P-5&6) shall be provided with all necessary seals, coatings, enclosures, casings, etc. to allow complete functionality outdoors and be weather resistant.

## 2.12 AIR COOLED CHILLER

### A. SUMMARY

1. This Section includes design, performance criteria, refrigerants, controls, and installation requirements for air cooled centrifugal chillers.

### B. REFERENCES

1. Compliance is with the following codes and standards:
  - a. ARI 550/590 NEC
  - b. ANSI/ASHRAE 15
  - c. ASME Section VIII
  - d. ETL Listed
  - e. ANSI UL 1995
  - f. CSA C22.2 No. 236 (Canada)
  - g. OSHA as adopted by the State

### C. SUBMITTALS

1. Submittals shall include the following:
  - a. Dimensioned plan and elevation drawings, including required service clearances and location of all field piping and electrical connections.
  - b. Electrical and water quality requirements during operation, standby and shutdown.

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- c. Control system diagram showing points for field interface and connection to external BMS systems. Drawings shall show field and factory wiring.
  - d. Installation and Operation Manuals.
  - e. Manufacturers certified performance data as per AHRI at full load and IPLV or NPLV.
- D. QUALITY ASSURANCE
- 1. Regulatory Requirements: Compliance with the standards in Section 1.2.
- E. DELIVERY AND HANDLING
- 1. Chillers shall be delivered to the job site completely assembled (unless otherwise specified).
  - 2. Compliance shall be with the manufacturer's instructions for transportation and rigging.
- F. WARRANTY and MAINTENANCE
- 1. The chiller manufacturer's warranty shall be for a period of one year from date of equipment start up or 18 months from the date of shipment, whichever occurs first.
  - 2. The warranty shall include parts and labor costs for the repair or replacement of parts found to be defective in material or workmanship.
  - 3. Maintenance of the chiller equipment while under warranty, is mandatory and shall be the responsibility of the purchaser, unless supplied by the manufacturer.
  - 4. Optional:
    - a. Extended chiller parts and labor warranty.
    - b. 2-5-year compressor parts and labor.
    - c. 2-5 year chiller parts and labor warranty.
- G. ACCEPTABLE MANUFACTURERS
- 1. Smardt Inc.
  - 2. MultiStack
  - 3. ArticChill
  - 4. Approved Equal. Note approved equal does not automatically imply the alternate product matches this specification, functionality or delivered quality.
- H. PRODUCT DESCRIPTION
- 1. Provide and install as shown on the plans, a factory assembled air-cooled packaged chiller.
  - 2. Each unit shall include one or more Turbocor oil-free magnetic bearing and variable-speed centrifugal compressors. Integrated variable frequency drive shall operate with inlet guide vanes to optimize part load efficiency. Chillers shall operate with HCF-134a refrigerant - not subject to phase-out by the Montreal Protocol and the U.S. EPA clean air act.



3. The evaporator, condenser, and expansion valve shall be configured to operate as a single refrigerant circuit unless otherwise specified. The chiller unit compressors shall be designed for mechanical and electrical isolation to facilitate service and removal.

I. DESIGN REQUIREMENTS

1. Unit shall consist of one or more magnetic bearing oil-free centrifugal compressors with integrated variable frequency drive, refrigerant flooded evaporator, air cooled condenser, and operating controls with equipment protection.
2. Performance: Refer to schedule for specific operating conditions. The chiller shall be capable of stable operation down to 15 percent capacity. All these ratings are measured at standard AHRI entering condenser water temperatures and without utilizing hot gas bypass.
3. Acoustics: Sound pressure for the unit shall not exceed 83 dBA, measured at 1 meter (3.28 ft.). Sound data shall be measured according to AHRI Standard 370.
4. Chiller shall be equipped for single-point power connection.

J. CHILLER COMPONENTS

1. Compressors:
  - a. Compressors shall be of semi-hermetic centrifugal design and operate oil-free with two-stages of compression, magnetic bearings, movable inlet guide vanes and integrated variable frequency drive system.
  - b. Automatically positioned and controlled inlet guide vanes shall operate with compressor speed controls.
  - c. The compressor shall be capable of coming to a controlled stop in the event of a power failure. The unit shall be capable of initializing an automatic restart in the case of power failure.
  - d. Each compressor shall have integrated microprocessor control capable of capacity and safety control.
  - e. Each compressor shall be installed with individual suction, discharge and motor cooling refrigerant line isolation valves. Chillers without discharge line isolation valves that rely on non-return valves in the discharge line for compressor removal, shall not be accepted.
  - f. Each compressor shall have an individual disconnect switch. On chillers that are provided with more than one compressor, each compressor shall have mechanical and electrical isolation to allow the chiller to operate when a compressor is removed.
  - g. Optional:
    - 1) EMI filters installed for each compressor.

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2. Evaporator:

- a. Evaporator shall be shell-and-tube type and shall be designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII Code Case 1518-5. Refrigerant shall be in the shell and water inside the tubes. The water sides shall be designed for a minimum of 150 psig or as specified. Vents and drains shall be provided. The refrigerant side shall bear the ASME Code stamp. Vessels shall pass a test pressure of 1.1 times the working pressure but not less than 689 kPa (100 psig). Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor suction ports. The evaporator water connections shall also be equipped with right-hand or left-hand connection, interchangeable.
- b. A perforated plate designed for vapor disengagement shall be installed inside the evaporator above the tubing, to ensure effective liquid droplet removal, to prevent liquid damage to compressors, and to equalize suction pressure across evaporators with multiple compressors.
- c. Tubes shall be individually replaceable and have internally and externally enhanced surfaces designed for refrigeration duty. Tubes shall have smooth full tube wall landings at the tube-sheet ends and at intermediate tube supports. Tubes shall be mechanically roller expanded into steel tube sheets containing a minimum of three concentric grooves.
- d. Minimum evaporator exiting water temperature shall be 3.3°C (38°F). Minimum entering condenser air temperature shall be 0°C (32°F). Minimum inlet condenser air to outlet chilled water difference shall be - 11.1°C (12°F).
- e. The evaporator, including chilled water boxes, compressor suction line, compressor end bell, and all other components, subject to condensing moisture, shall be insulated with UL recognized ¾ inch closed cell insulation. All joints and seams shall be sealed to form a vapor barrier.
- f. Optional:
  - 1) Marine water boxes.
  - 2) Epoxy-coating of inside surfaces of water boxes and tube sheets.
  - 3) Water side vessel design for of 300 psi operation.
  - 4) Double insulation, 1½ inch, on evaporator, water boxes, suction piping.

3. Air-Cooled Condenser:

- a. Air cooled packaged chillers and controls shall be capable of reliable operation between 0 deg. C (32 deg. F) and 40.6 deg. C (105 deg. F) ambient air temperature.
- b. Air-cooled condensers shall utilize mill-coated hydrophilic-blue aluminum fins with refrigeration duty copper tubes mechanically expanded into fin collars. Condenser coils shall be arranged in a W-configuration to reduce equipment footprint.
- c. Condenser coils and fans shall be arranged such that one fan operates with one coil section so that the failure of a fan will not affect the CFM across any coil beyond that fan. The standard coating shall meet ASTM B117 2000hr salt spray test.

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- d. The condenser shall be equipped with an oversized liquid line and mechanical float to ensure liquid sub-cooling necessary for effective cooling of the compressor.
  - e. The condenser shall be equipped with packaged fixed or variable speed fans capable of delivering specified CFM of air according to ARI standard operating conditions. The fan motors shall be high efficiency, direct drive, 3-phase, insulation class "F", current protected, Totally Enclosed Air Over (TEAO), double sealed and with permanently lubricated ball bearings.
  - f. The fans shall be low sound. They shall be balanced dynamically and statically and direct drive. Also, the blades shall be corrosion resistant designed for low noise, full airfoil cross section, providing vertical air discharge from extended orifices. The guards shall be constructed of heavy duty 14 gauge steel and painted.
  - g. Optional:
    - 1) The coating system for HVAC coil corrosion resistance provides a lifetime protection against micro-organism contamination that causes unwanted odors, and shall pass a 10,000 hour salt spray test. Next to anti-corrosion protection and energy conservation of the total system, the coating shall prevent adhesion of dirt and growth of micro-organisms, and shall also prevent chemical, galvanic, and microbial corrosion.
    - 2) Low ambient kit shall allow operation down to 9.4 deg. C (15 deg. F).
4. Refrigeration Components
- Liquid Level Controls:
- a. Control of refrigerant flow shall utilize a single or multiple 6,000 step electronic expansion valve (EXV), to operate within the full range from full load to the lowest loading capacity for the chiller. Fixed orifice metering devices or float controls using hot gas bypass are not acceptable. The EXV liquid line shall have a sight glass with moisture indicator and temperature sensor connected to the control system for validation of sub-cooling.
  - b. The condenser shall be provided with a capacitive type liquid level transducer with a resolution of not less than 1024 discrete steps. The transducer shall be wired to the chiller control system. Condenser liquid level measurement shall be used in the electronic expansion valve control algorithm with a minimum level set point to ensure adequate liquid seal is maintained in the condenser, to provide compressor motor cooling during operation. Condenser liquid level shall be clearly displayed on the graphical operator interface in a minimum of two screens. Chillers without direct level measurement are prohibited, due to possible over heating damage that may occur in compressors when liquid seal is lost.
  - c. Each compressor shall be installed with individual suction, discharge, and motor cooling refrigerant line isolation valves. Chillers without discharge line isolation valves that rely on non-return valves in the discharge line for compressor removal, shall not be accepted.
  - d. To prevent unit operation with no water flow, factory mounted and wired thermal dispersion water flow switches shall be provided on the condenser.

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- e. The condenser shall be equipped with a mechanical stainless steel float for electronic actuation of the EXV, so as to provide a positive liquid seal to ensure effective cooling of the compressor
  - f. The evaporator shall be provided with spring loaded reseating type pressure relief valves, in accordance with ASHRAE-15. Rupture discs are not acceptable.
  - g. Load balancing valves shall be provided for capacity control and additional temperature stability.
  - h. There shall be a backup superheat control on the inlet of the compressor, in order to control the EXV in the event of a failure of the primary level sensing device.
5. Prime Mover:
- a. A permanent-magnet, synchronous hermetically sealed motor of sufficient size to effectively provide compressor horsepower requirements. The motor shall include soft-start capabilities with an in-rush current of no more than 2 amps (TT300 models) and 4 amps (TT400 models). The motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase.
  - b. The compressor motor and chiller unit shall include variable frequency speed controls to match cooling load demand to compressor speed and inlet guide vane position.
  - c. Each compressor shall be equipped with an AC line reactor and individual disconnect.
6. Chiller Frame & Housing
- a. All components shall be mounted onto a unitized construction, having a galvanized welded steel frame suitable for outdoor installation.
  - b. Compressors and controls shall be contained within a sheet metal enclosure to protect critical components from the weather.
7. Chiller Controls
- a. The controller fitted to the oil-free centrifugal chiller package shall be an embedded real time microprocessor device that utilizes control software written specifically for chiller applications. User operation shall be accomplished using a panel mounted color touch-screen interface. The status of the compressors and all system parameters, including compressor alarms and temperature trends, shall be viewable.
  - b. G1. The chiller control system shall have the capability of storing one year of operational data. No less than 60 points of information shall be sampled at a maximum of 15 minute intervals.
  - c. G2. The chiller control system shall have full web based remote control capability; including the capability of remote operation and software updates.
  - d. Controller features must include the following:
    - 1) Selectable control mode – leaving chilled water, entering chilled water, or suction pressure control.

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- 2) 10.4-inch or 12.1-inch or 15-inch, 65,000 colors, touch panel operator interface operating windows embedded.
  - e. Chiller documentation shall be viewable via touch panel in pdf format.
  - f. Operator interface shall be capable of connecting directly to compressors via serial communication protocol and display compressor information using Turbocor compressor monitoring / commissioning software.
  - g. Chiller control panel shall contain a minimum of three processors; all control functionality shall be carried out on a dedicated real time processor and data served to a remote graphical user interface via an open Ethernet protocol. Proprietary protocols between any pc based or micro based processor are strictly prohibited.
  - h. Chiller controls shall be native BacNet-IP capable. Addition of gateway devices or additional processors or pluggable PCBs to achieve BacNet communications to the BAS is strictly prohibited.
  - i. Complete configuration of native BAS communications via BacNet IP shall be made via standard chiller controller graphical user interface. Chiller controls that utilize external software configuration tools to configure these protocols are explicitly prohibited.
  - j. Chiller control shall be capable of controlling up to eight Turbocor compressors on up to eight individual refrigerant circuits serving the same chilled water stream.
  - k. Chiller control panel user interface shall be capable of remote control via an internet connection without the use of any third party gateway device or additional hardware or software.
  - l. Chiller control shall be capable of operating in headless mode (no touch panel connected) and utilize standard windows or higher computer to display user interface via Ethernet connection.
  - m. Real time chiller control processor shall be capable of e-mailing a predefined list of recipients, should a fault occur. E-mail shall include details of fault, possible reason for fault, attachment of monthly data log of 195 or more compressor and chiller variables, and at a minimum interval of 30 seconds and with indication of severity of fault.
  - n. Ability to place all outputs in a manual state (hand, off, auto) via graphical user interface.
  - o. Alarm screen shall be capable of filtering faults into specific categories such as compressor, chiller and system faults in order to provide rapid diagnosis, and separation of failure modes.
  - p. Variable speed cooling tower control.
  - q. Optional variable speed condenser water pumping control.
  - r. Optional ability to turn on/off duty standby chilled water pumps.
  - s. Optional ability to turn on/off duty standby condenser water pumps.
  - t. Optional ability to operate chiller isolation valves for both evaporator and condenser.

- u. Multiple compressor staging algorithm shall operate at the optimized power curves of each compressor simultaneously, and shall reset automatically every second during operation. Compressor staging methods that operate using simple incremental percent of demand shall not be accepted.
- v. Continuous data logging for operational trending and bin analysis shall be exportable to "CSV" format. (12 months data stored).
- w. Embedded Web and FTP servers to enable remote encrypted control, log download, software version upload, and operational monitoring.
- x. Built-in stepper motor controls for EXVs.
- y. Controls lockup protection.
- z. Ramp rate control - Peak energy demand limiting algorithms.
- aa. Three levels of alarm safety for minimum chiller down time.
- bb. Chiller control software shall employ an active fault avoidance algorithm to reduce chiller capacity and/or power level in the case of the chiller approaching within 10% of any trip limit value such as suction pressure, discharge pressure, chiller amp limit, leaving chilled water temperature limit, etc...
- cc. Store up to 32,000 alarm and fault events stored with date / time stamp.
- dd. Real time data trending viewable via touch panel.
- ee. Chiller load profile charts viewable via touch panel.
- ff. Chiller control graphical user interface shall be capable of displaying data in SI or I-P units without affecting control or BAS protocol units.
- gg. Optional:
  - 1) BMS interface module for the interface with BacNET IP shall be provided.
  - 2) Data on Main Display Screen shall include:
    - a) Entering and leaving chilled water temperatures.
    - b) Entering and leaving condenser water temperatures.
    - c) Current operating state of chiller.
    - d) Active timers.
    - e) Chiller enable status.
    - f) Chiller water flow proof status.
    - g) Condenser water flow proof status.
    - h) Indication of compressor readiness.
    - i) Indication of clearance to run.
    - j) Chiller set point.
    - k) Total chiller kW.
    - l) Total chiller current input.
    - m) Three pages of data trends with zoom functionality.

- n) Graphical dial indicators that clearly indicate safe and unsafe operating values.
- o) Graphical representation of evaporator and condenser showing gas movement when chiller is running.
- p) Current alarms (announce and manual reset provision).
- q) Compressor actual rpm, maximum rpm, minimum rpm.

K. EXECUTION

1. INSTALLATION

- a. Install per manufacturer's IOM documentation, shop drawings, and submittal documents.
- b. Align chiller on foundations or mounting rails as specified on drawings.
- c. Arrange piping to enable dismantling and permit head removal for tube cleaning.
- d. Coordinate electrical installation with electrical contractor.
- e. Coordinate controls and BMS interface with controls contractor.
- f. Provide all material required for a fully operational and functional chiller.

2. START-UP

- a. Units shall be field charged with ant. HFC-134a refrigerant.
- b. Factory Start-Up Services: Provide factory supervised start-up on-site for a minimum of two working days and ensure proper operation of the equipment. During the period of start-up, the factory authorized technician shall instruct the owner's representative in proper care and operation of the equipment.

2.13 ROOFTOP AIR HANDLING UNITS (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)

A. General

- 1. Rooftop air handling units shall be capable of 100 percent dedicated outside air design (DOAS). Units shall be of the configuration, capacity, and style as indicated on the drawings and Equipment Schedule and as specified herein. Through properly designed access; ease of maintenance, removability of components, and unit serviceability shall be assured.
- 2. The unit shall be constructed for outdoor installation. Outdoor unit to be provided with weatherproof outside air intake hood with aluminum mesh screen and shutoff dampers for supply, return and exhaust.
- 3. Where Gas Fired Rooftop units are scheduled, as a whole (and not individual components) must be Mass approved and on the Massachusetts Board of Registration of Plumbers and Gas Fitters as a listed and accepted manufacturer.

B. General Description

- 1. Furnish as shown on plans. Unit performance and electrical characteristics shall be per the job schedule.

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2. Provide the unit with the following sections as a minimum:
    - a. Modulating exhaust fan/economizer section
    - b. Filter sections
    - c. Modulating supply fan section
    - d. Access sections
    - e. Modulating direct expansion cooling coil section
    - f. Diffuser (as required)
    - g. Discharge/intake plenums
    - h. Chilled water cooling coil
    - i. Hot Water Heating Coil (or Gas Fired Heating Section if scheduled)
    - j. Static Membrane Plate Total Energy Recovery and Re-Heat Heat Exchangers
  3. The complete unit shall be ETL listed. The burner and gas train for the unit furnace shall be IRI/FIA approved.
  4. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Units shall be of a modular design with factory installed access sections available to provide maximum design flexibility.
  5. Unit is to be shipped factory assembled in one complete section, when possible. Each unit shall be either completely factory assembled and shipped in one piece or split at the condensing section and/or split between the supply fan section and the heat section. Packaged units shall be shipped fully charged with Refrigerant R410A. Units split between the evaporator and the condensing sections are shipped with a nitrogen holding charge only. Unit manufacturer and subcontractor shall coordinate ship split and field installation, refrigerant charging, and all unit field inter-connection requirements.
  6. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the supply and return fan assemblies, a refrigeration circuit run test, a unit control system operations checkout (for controls provided with unit), test and adjustment of the gas furnace, a unit refrigerant leak test and a final unit inspection.
  7. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
  8. The Rooftop unit shall be designed, manufactured, and independently tested, rated, and certified to meet the seismic standards of the 2015 International Building Code and ASCE 7-06.
    - a. Certificates of Compliance shall be provided with the submittal and include the manufacturer's identification, designation of certified characteristics, and the Independent Certifying Agency's name and report identification.
    - b. Clear installation instructions shall be provided including all accessory components.
  9. Performance: All scheduled capacities and face areas are minimum accepted values. All scheduled amps, kW, and hp are maximum accepted values that allow scheduled capacity to be met.



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10. **Warranty:** The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence upon project completion date. Construction Manager and unit manufacture shall provide extended warranty if units are used for temporary heating/cooling purposes.
  11. **Quality Assurance:** All unit(s) shall be factory run tested before shipping. A proof copy of the test shall be placed in the unit electrical power & control panel. Unit(s) shall bear the ETL label, tested in accordance to UL 1995. Electrical components shall be UL listed; fans shall be tested in an AMCA certified laboratory; insulation shall comply with NFPA 90A; water coils shall be tested in accordance to AHRI 410 ; energy recovery exchangers shall be in accordance to AHRI 1060, "Rating Air-to-Air Energy Recovery Equipment" and Eurovent standards; filters shall be tested in accordance to ASHRAE 52. The unit manufacturers construction shall have an independent testing agency test the air leakage, panel deflection and sound pressure levels for supply airflows of minimum 20,000 CFM. The air leakage of the unit(s) shall not exceed 1% at 8" inches H2O positive static pressure and a copy of the report must be submitted upon request. Unit shall be constructed to limit frame and panel deflection to 1/250th of the panel length at 8" inches H2O positive static pressure and a copy of the report must be submitted upon request. The unit shall also be tested in accordance with ANSI S12.34-1998 and instrumentation used must be in compliance with the requirements of AMCA 300 for sound readings. The sound tests conducted shall report overall sound power and pressure readings for supply air outlet, return air inlet and casing radiated.
  12. **FIELD INSPECTION:** The manufacturer who is basis of design will reserve the right to field inspect the units, whether they are awarded the job or not, and shall provide a written report to the engineer noting any deficiencies to the bid specifications. If there are any deficiencies or missing items on the units shipped which are clearly mentioned in the bid documents, regardless of what is approved by the engineer on the submittals, the units shall be returned to the manufacturer for them to be corrected at the contractor's expense.
- C. Cabinet, Casing and Frame
1. Provide double-wall construction for all side wall access doors and floor areas shall be provided with 18 gauge exterior and 20-gauge interior, solid G60 galvanized steel construction. Inner liners shall protect insulation during service and maintenance. Unit cabinet shall be designed to operate at total static pressures up to 6.5 in. s w.g.
  2. Insulation on ceiling and end panels shall be secured with adhesive and mechanical fasteners. Heavy gauge solid galvanized steel liners shall be provided throughout, allowing no exposed insulation within the air stream.
  3. All cabinet insulation, except floor panels, shall be a nominal 2 in. thick, R8.5, glass fiber. A combination of solid and perforated galvanized steel liners shall be provided throughout. Perforated liners to be used in the supply and return air plenums to provide improved sound attenuation. Insulation under perforated liners shall be coated with hospital grade liner rated in accordance with standard ASTM C-1071.
  4. All floor panels shall include double wall construction and include a nominal 2 in. thick, R-12 foam or fiberglass insulation.

5. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished surface shall withstand a minimum 2000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance and ASTM D4585 2000-hour moisture condensation resistance test.
  6. Service doors shall be provided on both sides of each section in order to provide user access to all unit components. Finish color shall be as selected by Architect from Manufacturer's available colors.
  7. Service doors shall be constructed of heavy gauge galvanized steel with a gauge, galvanized steel interior liner. All service doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system that is operated by a single, flush-mounted handle. The latch system shall feature a staggered engagement for ease of operation. Removable panels, or doors secured by multiple, mechanical fasteners are not acceptable.
  8. The unit base frame shall be constructed of 13-gauge pre-painted galvanized steel. The unit base shall overhang the roof curb for positive water runoff and shall have a formed recess that seats on the roof curb gasket to provide a positive, weather-tight seal. Lifting brackets shall be provided on the unit base with lifting holes to accept cable or chain hooks.
- D. Gas Heating Section (Make-Up Air Unit Only)
1. A natural gas fired furnace shall be installed in the unit heat section. The heat exchanger shall include a type 321 stainless steel cylindrical primary combustion chamber, a type 321 stainless steel header, type 321 stainless steel secondary tubes and type 321 stainless steel turbulators. Carbon and aluminized steel heat exchanger surfaces are not acceptable.
  2. The heat exchanger shall have a condensate drain.
  3. Clean out of the primary heat exchanger and secondary tubes shall be accomplished without removing casing panels or passing soot through the supply air passages.
  4. The furnace section shall be positioned downstream of the supply air fan.
  5. The furnace will be supplied with a modulating forced draft burner. The burner shall be controlled for low fire start. The burner furnace shall be supplied with a forced draft burner capable of continuous modulation between eight percent and 100 percent (min 12:1 turn-down) of rated capacity, without steps for units under 30 tons. A 10:1 turndown furnace may be provided if a refrigeration heat pump option is provided and utilized in conjunction with the 10:1 turndown furnace. A minimum of 20:1 shall be provided for units over 30 tons. The burner shall operate efficiently at all firing rates. The burner shall have proven open damper low-high-low pre-purge cycle, and proven low fire start. The combustion air control damper shall be in the closed position during the off cycle to reduce losses.

6. The burner shall be specifically designed to burn natural gas and shall include a microprocessor based flame safeguard control, combustion air proving switch, prepurge timer and spark ignition. The gas train shall include redundant gas valves, regulators compatible with project gas pressure requirements, shutoff cock, pilot gas valve, pilot pressure regulator, and pilot cock. The burner shall be rated for operation and full modulation capability at inlet gas pressures down to 6.5 in. W.C. The gas burner shall be controlled by the factory installed main unit control system.
7. The burner shall have electric ignition, standing pilot lights are unacceptable.
8. The burner shall be fired, tested and adjusted at the factory. Final adjustments shall be made in the field at initial startup by a qualified service technician to verify that installation and operation of the burner is according to specifications.
9. Flue collector construction shall consist of type 409 stainless steel. Where applicable by LEED or code requirements, flue discharge with weather cap shall discharge a minimum of two ft. higher than outdoor air intakes located closer than 25 ft. from flue discharge. Provide stainless steel flue extensions with weather cap for all units that are within this 25 ft. range of outside air intakes.

E. Filters

1. Unit shall be provided with filter sections. The filter sections shall be supplied complete with the filter rack as an integral part of the unit. The draw-through filter section shall be provided with panel and cartridge filters.
2. Filters shall be frame mounted and shall slide into galvanized steel racks contained within the unit. Filters shall be installed in an angular arrangement to maximize filter area and minimize filter face velocity. Filters shall be accessible from both sides of the filter section.
3. PRE-FILTERS (HIGH CAPACITY SERIES 400 2" MERV 10) - Filters shall be factory installed upstream of the heat exchanger and coils, in both airstreams. The filters shall be Filtration Group Series 400, MERV 10. Each filter shall consist of 100% synthetic media, expanded metal on the downstream and enclosing with high wet-strength beverage board with diagonal support bonded on air entering and air exiting side of each pleat. MERV 10 model High Capacity Serie 400 filters, UL 900 classified are rated as per ASHRAE test 52.2.2012 at 88% efficiency initial (based on Minimum Average Efficiency) at 3-10 microns. The model High Capacity Serie 400 could be operated at 500 FPM, surface area 18 FT<sup>2</sup> of media based on 24 x 24 x 2 initial static pressure at 0.24", final will be 1". Filters shall be placed in a completely sealed, galvanized holding frame with quick release latches for easy replacement.
4. Final Filters – Supply Airstream - Four inch deep MERV 13, efficient, UL Std. 900, Class 1, AmericanAirFilter cartridge filters shall be provided. Two in. panel, MERV-8 efficient pre-filters shall be included. Aluminum mesh outside air filter shall be provided at the outside air hood inlet. Cartridge filters shall consist of filter media permanently attached to a metal frame and shall slide into a gasketed, extruded aluminum rack contained within the unit. The filter rack shall have secondary gasketed, hinged end panels to insure proper sealing. Filters shall be accessible from both sides of the filter section. Filter set quantities shall be provided as indicated in Part III.
5. Clogged filter switches and magnehelic gauges shall be provided on all filter all sections.

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- F. Outdoor/Exhaust/Return Air Section
1. Outdoor/Exhaust/Return Air Plenum- Unit shall be provided with a, outdoor/exhaust/return air plenum capable of handling 100 percent re-circulated air. The 100 percent return air plenum shall allow return air to enter from the bottom of the unit. Low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 0.2 percent at 1.5 in. static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a field installed modulating actuator provided by the ATC Sub-subcontractor.
- G. OA WEATHER HOOD: The outdoor intake weather hood shall be completely constructed in aluminum for superior corrosion resistance. The hood shall ship loose for field installation by the installing contractor. Painted galvanized hoods shall not be acceptable due to its susceptibility to corrosion. The outdoor air hood shall be designed with a 4" extruded aluminum louver, bird screen and a plenum enclosure with drain holes. The louver blades shall be drainable type with a maximum 45 degree angle and curved with integral rain baffle. The louver design shall not allow more than 0.03 oz/ft<sup>2</sup> water penetration when tested in accordance to AMCA 500. The pressure drop of the complete hood assembly shall not exceed 0.05"wc at a maximum 500 fpm face velocity. A Pre-filter rack system shall be installed within the weather hood enclosure to prevent outdoor air dust and debris from entering the damper and unit casing plenum. Pre-filters installed inside the unit casing plenum and downstream of the outdoor damper will not be acceptable as this will increase overall maintenance on the damper, reduce indoor air quality and promote mold and bacteria growth. Filter access in the hood shall be accomplished via the louver that is installed with a stainless steel piano hinge and spring loaded latch. No tools or ladders shall be required to access the pre-filters in the weather hood assembly. The exhaust air outlet louvers shall be 2" extruded aluminum, with non-restricting blade design and bird screen.
- H. Energy Recovery Section and Components
1. FIXED PLATE HEAT EXCHANGERS: Fixed plates heat exchangers shall factory installed where indicated on drawings. The heat exchanger shall be a cross flow plate air-to-air type. The alternate layers of plate create two ducts, one for supply air and one for exhaust air. The plates shall be in pure aluminum for its characteristics of corrosion resistance, ease of manufacture, flame proof, durability and excellent heat transfer properties (option: For aggressive and corrosive applications, the plates shall be coated aluminum or various grades of stainless steel. For special applications with high temperature, plates shall be stainless steel). Minimum plate thickness shall be .008", with positive and negative stamping for spacing and turbulence. The plates shall be sealed at air entry and exit to avoid air leakage and separate exhaust and supply air by proper seals. The plates shall be housed inside a casing composed of corner profiles and side walls. The corners of the exchanger package shall be cast and sealed into especially rigid aluminum extrusions in the casing with permanent elastic non acetic silicone. The side walls shall be manufactured from galvanized steel sheets and bolted to the aluminum extrusions. Plates shall be able to withstand up to 10" pressure differential and 400°F operating temperature when required. The fixed plate heat exchanger assembly shall be tested in accordance to ARI1060 and to ASHRAE 84-91. Access for all four sides of the heat exchanger shall be provided for cleaning and inspection. Temperature and pressure drop

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- performance shall be equal or less than what is scheduled. Stainless Steel drain pan shall be provided underneath the entire Fixed Plate with 1" PVC drains on each 4 sides of the heat exchanger. Drain connections protrude through the side of the unit. Note: Drain lines must be properly trapped and freeze protected in field. Frost control shall be accomplished by face & bypass damper where temperatures fall below freezing. Any other form of defrost shall not be acceptable.
2. ENTHALPY PLATE HEAT EXCHANGERS: Enthalpy plates heat exchangers shall be factory installed where indicated on drawings. The heat exchanger shall be a cross flow plate air-to-air type. The alternate layers of plate create two ducts, one for supply air and one for exhaust air. The plates shall be in pure porous membrane with the ability to transfer sensible and latent heat. The plates shall be sealed at air entry and exit to avoid air leakage and separate exhaust and supply air by proper seals. The plates shall be housed inside a casing composed of corner profiles and side walls. Plates shall be able to withstand up to 4" pressure differential. The plate heat exchanger assembly shall be tested in accordance to AHRI1060 and to ASHRAE 84-91, or EUROVENT standard. Access for all four sides of the heat exchanger shall be provided for cleaning and inspection. Temperature and pressure drop performance shall be equal or less than what is scheduled. Stainless Steel drain pan shall be provided underneath the entire Plate with 1" PVC drains on each (2) or 4 sides of the heat exchanger. Drain connections protrude through the side of the unit. Note: Drain lines must be properly trapped and freeze protected in field. Frost control shall be accomplished by face & bypass damper where temperatures fall below freezing. Any other form of defrost shall not be acceptable.
- I. FANS: The fans shall be carefully positioned and installed at an optimal distance to respect uniform airflow across the heat exchanger & coil(s).
    1. Plenum Fans ER model: Fans shall be direct drive radial centrifugal fans with free running impeller. No fan belts will be acceptable for this application. Fans shall be compact, optimized and construction made of galvanized sheet steel with backward curved 7-blade high efficiency impeller, protected by an epoxy powder coating. To reduce vibration, the impeller shall be balanced with hub to an admissible vibration severity of less than 2.8 mm/s in conformity with DIN ISO 14694 and proof shall be supplied for each individual impeller. Tests shall be made according to DIN ISO 1940 Part 1, quality of balancing G2.5/6.3. The single inlet shall be mounted onto constant speed direct drive motor, equipped with an air flow optimized inlet cone from galvanized sheet steel. Fans shall be completely certified as per ISO 5801 and in accordance to AMCA standards. Fan/ fan bank will require to be operated by a Variable speed drive or one VFD per fan shall be provided w/ Automatic Control backdraft isolation damper that shall close in event of a fan failure. Plenum fan shall come equipped with guard grilles for the air intake side.
    2. The fan housing and motor assembly shall be isolated from the unit cabinetry with a minimum 95% efficient isolators. Fan(s) shall have flexible duct canvas and galvanized spring isolators. Painted isolators are unacceptable. Provide Heavy duty rubber isolators for all fan sizes.

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3. Plenum Fans GR model: Wall mounted, direct driven plenum fans (horizontal or vertical) shall be installed with perimeter gasketed isolation. Fans shall be direct drive radial centrifugal fans with free running impeller. Fans shall be compact, optimized and construction made of galvanized sheet steel with backward curved 7-blade high efficiency impeller, protected by an epoxy powder coating. To reduce vibration, the impeller shall be balanced with hub to an admissible vibration severity of less than 2.8 mm/s in conformity with DIN ISO 14694 and proof shall be supplied for each individual impeller. Tests shall be made according to DIN ISO 1940 Part 1, quality of balancing G2.5/6.3. The single inlet shall be mounted onto constant speed direct drive motor, equipped with an air flow optimized inlet cone from galvanized sheet steel. Fans shall be completely certified as per ISO 5801 and in accordance to AMCA standards. Fan/ fan bank will require to be operated by a Variable speed drive or one VFD per fan shall be provided w/ Automatic Control backdraft isolation damper that shall close in the event of a fan failure . Optional: Plenum fan shall come equipped with guard grilles for the air intake side.
  4. The fan housing and motor assembly shall be isolated from the unit cabinetry with a minimum 95% efficient spring isolators or high efficiency rubber isolators or seismic isolators. In addition, fans shall have flexible canvas to reduce vibration transmission.
  5. SOUND ATTENUATION IN FAN COMPARTMENT: The fan section shall be constructed with a perforated interior liner, same construction as the housing interior lining and shall be insulated with Permacote anti-microbial coating fiber glass. The perforated lining shall be installed on fixed panels only, with exception on the interior ceiling.
  6. FAN MOTORS: The fan motors shall meet NEMA standard dimensions and comply with the Energy policy Act of 1997. Motors shall have premium efficiencies with low noise and vibration output. Motors shall be certified and built in accordance to ISO 9001 quality control system. Motors shall have ODP enclosure with Premium efficiency rating.
  7. A shaft grounding brush kit will be provided to prevent electrical damage to motor bearings by safely channeling harmful shaft currents to ground.
  8. VARIABLE FREQUENCY DRIVE (VFD) – VFDs will be used to set or regulate the fan speed and airflow for these units. The VFD shall have PID function for constant flow applications. The VFDs will be installed with integral brake transistor, overload protection, and adjustable pulse-width modulation (PWM). The VFD shall use Insulated Gate Bipolar Transistor (IGBT) technology to convert three phase input power to coded PWM output and have 4-20mA analog output terminals that are fully programmable for variable flow applications. The VFD shall be equipped with a keypad with status indicators, easy access functions, and monitoring functions during motor operation. In the event of a momentary power failure or fault the VFD shall read the inverter speed and direction of a coasting motor and shall automatically restart the motor smoothly. Technical support will be provided by the VFD manufacturer. VFDs shall be installed as shown on drawings with contactors, relays, and all specified accessories. VFDs will be installed with 3% line reactors and manual bypass.

- J. Dampers: Dampers shall be installed where shown on the drawings. Dampers shall be low leak type with rubber edges, opposed blades, and constructed from extruded aluminum. Galvanized dampers will not be acceptable. The exhaust air outlet shall have a standard aluminum gravity type damper, unless otherwise noted below.
1. Dampers shall be installed in the compartments (as shown on the drawings) with linkage rod for actuators:
  2. Actuators shall be 24V factory and furnished by the ATC contractor; two-position or modulating type (please refer to the unit schedule). All actuators shall have spring return mechanism and auxiliary switches. Dampers will be installed in the failed close position unless otherwise noted.
- K. WATER COILS
1. Coils shall be are factory installed in the unit. Primary surface shall be round seamless 5/8" OD copper tube staggered in the direction of airflow. Secondary surface shall consist of rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Casing shall be constructed of continuous stainless steel. Coils shall be circuited for counter-flow heat transfer to provide maximum mean effective temperature difference for maximum heat transfer rates. Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility. The complete coil shall be tested with 315 pounds air pressure under warm water and be suitable for operation at 250 psig working pressures. Maximum finned coil height shall be 60" and shall not exceed 500 FPM face velocity.
  2. Drain pan shall be provided for cooling coils. Cooling coils shall sit on stainless steel tubular support rails, which shall stand a minimum of (2) two inches above the highest point of the floor drain pan. Stacked coils shall be provided for larger airflows and intermediate drain pans shall be provided for each coil bank. Drain pans shall be 1.25" stainless steel with stainless steel drain connections on one side only. Pan shall be sloped in two planes. All coils shall be certified in accordance with ARI standard 410.

L. POWER & SAFETY CONTROL

1. The power and control center shall be integral to the unit housing and rated equivalent to NEMA 4X. UNDER NO CIRCUMSTANCES SHALL ANY WIRING OR PARTS BE FIELD INSTALLED. Panels that are externally mounted to the unit shall not be accepted, regardless of the NEMA rating they may have. A separate access door shall be provided with an approved locking device. All electrical components contained in the panel shall be UL/CSA certified and labeled. The unit shall be complete with VFDs, fuses, overloads (without VFD's or 2 motors on same VFD; one VFD per fan w/isolation damper), relays, phase protection for compressorized units, terminals for main ON/OFF and step-down transformer. All components shall be factory wired for single point power connection by the manufacturer of the unit. A non-fused safety disconnect switch shall be factory installed for ON/OFF servicing. An electrical pipe chase for power and control feeding shall be provided next to the control panel. Any power or control wiring that is field installed shall not be accepted under any circumstances. IF UNITS SHOW UP AT THE JOB SITE WITHOUT WIRING BY THE MANUFACTURER, THE CONTRACTOR WILL HAVE TO SEND BACK UNITS TO THE MANUFACTURER AT THE CONTRACTORS' EXPENSE TO GET THEM FACTORY WIRED AND RE-TESTED. The Short Circuit Current Rating (SCCR) is 5kA rms symmetrical, 600V Maximum.

M. SERVICE POWER & LIGHTING (Optional)

1. GFI, lights and switches shall be factory installed and wired to a common junction box. A separate power connection 120V/1 will be required. 120V/1 power will be connected to main power thru a transformer.

N. Access Sections - Unit shall be provided with factory installed access sections located as shown/indicated on the drawings. Access sections shall have hinged access doors on both sides of the section and shall have the same construction features as the rest of the unit.

O. Discharge and Return Plenum - A supply air discharge and return plenum shall be provided. The plenum section shall be lined with a perforated acoustic liner (rated per ASTM C1071 Standards) to enhance sound attenuation. The plenum section shall have a bottom discharge opening. Isolation dampers shall be provided in the bottom return air opening and bottom supply air openings. Actuators shall be provided by the ATC Sub-subcontractor to close the dampers when the fans are not running.

P. Roof Curb – refer to paragraph 2.3 within this specification.

Q. Controls

1. General – Automatic Temperature controls for Rooftop unit shall be DDC (direct digital control type). All sensors, actuators, controls shall be provided by the ATC/DDC controls Sub-subcontractor.
2. Unit manufacturer shall provide terminal strips for all manufacturer provided control devices not furnished by ATC Sub-subcontractor.
3. Refer to Control Diagram Drawings for Rooftop unit control requirements and expanded sequence of operation and required points list, for reference only.



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4. RTU manufacturer shall provide the necessary time and documentation to the ATC sub-subcontractor to provide seamless communication and point mapping to achieve the desired sequence and BMS interface.
- R. Manufacturers
1. Subject to compliance with requirements specified here within provide rooftop units as manufactured by Annexaire, Haakon, EAS, or approved equal by the engineer. (Rooftop Unit must fit within the footprint shown on the drawings with manufacturer's recommended service clearances and code mandated airstream clearances being maintained)
  2. Any substitution or equal manufacture must fit within the equipment footprint shown on the Drawings and meet the scheduled sound data.
- 2.14 TERMINAL HEATING UNITS (HYDRONIC) (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)
- A. Finned Tube Radiation:
1. General: Provide finned tube radiation of lengths and in locations as indicated, and of capacities, style, and having accessories as scheduled.
  2. Cabinets: Minimum 18-ga cold-rolled steel full backplate, minimum 14-ga front. Brace and reinforce front minimum of 4 ft.-0 in. o.c. without visible fasteners.
  3. Elements: Copper tube and aluminum fins, or steel tube and steel fin (as scheduled) with tube mechanically expanded into fin collars to eliminate noise and insure durability and performance at scheduled ratings.
  4. Finish: Flat black heat resisting paint for backplate; factory finished baked enamel on fronts and accessories. Submit color selection chart to Architect as part of submittal package.
  5. Accessories:
    - a. End panels, inside and outside corners, and enclosure extension.
    - b. Access panels in front of valves, balancing cocks, and traps.
    - c. Factory-mounted dampers.
    - d. Ball bearing hangers.
  6. Manufacturer: Subject to compliance with requirements, provide finned tube radiation of one of the following:
    - a. Vulcan Corp.
    - b. Rittling
    - c. Sterling Radiator; Div. of Reed National Corp.
    - d. Or equal

B. Hydronic Fan-Coil Units:

1. General: Provide fan-coil units having cabinet sizes, and in locations indicated, and of capacities, style, and having accessories as scheduled. Include in factory assembled unit, chassis, coils, freezestat, fanboard, fans, housing, ECM motor, filter, modulating 0-10V control valve package and insulation. All automatic controls and communication interface board for BMS integration shall be provided by the unit manufacture.
2. Chassis: Construct chassis of galvanized steel with flanged edges.
3. Insulation: Faced, heavy density glass fiber.
4. Cabinet: Construct of 16-ga steel removable panels, 16-ga front. Provide insulation over entire coil section. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer and finish paint color as selected by architect.
5. Coils: Construct of 5/8" seamless copper tubes mechanically bonded to configured aluminum fins. Design for 300 psi working pressure, and leak test at 300 psi under water.
6. Fans: Provide centrifugal forward curved double width wheels of reinforced fiberglass, in galvanized steel fan scrolls.
7. Motors: Provide ECM motors with integral thermal overload protection. Run test motors at factory in assembled unit prior to shipping. Provide quickly detachable motor cords. Provide speed dial for speed control.
8. Filters: Provide 1" thick MERV 8 throwaway type filters in fiberboard frames.
9. Accessories: Provide ducted inlet and outlet collars.
10. Manufacturer: Subject to compliance with requirements, provide fan-coil units of one of the following:
  - a. Rittling
  - b. Trane
  - c. McQuay Inc.
  - d. Or equal

C. Unit Heaters (UH) (Horizontal Type)

1. General: Provide horizontal unit heaters in locations as indicated, and of capacities, style, and having accessories as scheduled.
2. Construction:
  - a. Casings: Construct of steel, phosphatized inside and out, and finished with baked enamel. Provide adjustable face air diffuser.
  - b. Fans: Construct of aluminum and factory-balance. Design so motor and fan assembly is removable through fan outlet panel.
  - c. Coils: Construct of plate-type aluminum fins, mechanically bonded to copper tubes. Design coil for use in hot water applications.
  - d. Motors: Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

3. Manufacturer: Subject to compliance with requirements, provide horizontal unit heaters of one of the following:
  - a. Rittling
  - b. Sterling
  - c. Price
  - d. Or Equal.
  
- D. Unit Heaters (UH) (Cabinet Type)
  1. General: Provide cabinet unit heaters having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, motor, and insulation.
  2. Construction:
    - a. Chassis: Galvanized steel wrap-ground structural frame with edges flanged.
    - b. Insulation: Faced, heavy density glass fiber.
    - c. Cabinet: 14-ga removable front panel, 18-ga top and side panels. Insulate front panel over entire coil section. Provide access door on coil connection side. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer and baked enamel finish paint with color as selected by Architect. Provide sample selection chart.
    - d. Water Coils: Construct of 5/8 in. seamless copper tubes mechanically bonded to configured aluminum fins. Design for 300 psi and leak test at 300 psi under water. Provide same end connections for supply and return.
    - e. Fans: Provide centrifugal, forward curved double width fan wheels constructed of non-corrosive, molded, fiberglass reinforced thermo-plastic material. Construct fan scrolls of galvanized steel.
    - f. Motors: Provide shaded pole motors with integral thermal over-load protection, and motor cords for plug-in to junction box in unit. Provide motor speed switch with auxiliary contacts capable of being remotely controlled by the DDC system.
    - g. Filters: Provide 1 in. thick throwaway type filters in fiberboard frames.
  3. Manufacturer: Subject to compliance with requirements, provide cabinet heaters of one of the following:
    - a. Rittling
    - b. Sterling
    - c. Price
    - d. Or Equal.

E. Radiant Panels (RP)

1. Modular Radiant Panels:

- a. Modular radiant panels shall use heat sinks on the back of a rigid ceiling tile to transfer heat between copper tubes and the panel face. The modular radiant panels are to radiate or absorb heat from or to the zone below.
- b. Water Tubes: Tubes shall consist of ASTM B75 1/2" nominal copper tubing. Water connections shall be one end only. Water connections shall be suitable for solder, compression fittings, push-on fittings or threaded connection.
- c. Heat Sinks: Heat sinks shall be extruded aluminum and copper pipe will be mechanically fastened to the heat sink. A nonhardening heat transfer paste is required between the tubing and the heat sink and between the heat sink and the panel.
- d. Face: The panel face shall be constructed of 18 or 14 ga. aluminum
- e. Paint Finish: All visible components shall be powdercoated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Manufacturer shall provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN 14037 (heating) and DIN 14240 (cooling).
- f. Color to be chosen by Architect.
- g. Modular radiant panel capacity shall be tested and certified by manufacturer in accordance with DIN 14037 (heating) and DIN 14240 (cooling) to meet the performance listed on the schedule. Should any performance rating, chilled water supply temperature, water pressure drop, percentage of glycol, GPM or delta T deviate from the schedule, manufacturer shall submit updated capacity as described in Section 1.3, as well as computational fluid dynamic modeling demonstrating that any changes do not impact the air distribution in a room that would cause a detriment to the PMV and ADPI rating from the design conditions. Manufacturer shall have factory testing facility available to perform performance test of units in accordance with said standard, as required. Upon request, up to 1% of units for the project can be tested in accordance with the standard. Request will be made with order and prior to shipment of chilled sails. Engineer will have the option of witnessing this test.
- h. Water connections shall be shipped sealed to limit the introduction of dust and dirt during shipping and construction.
- i. Accessories:
  - 1) Manufacturer shall supply upon request 12"/18" stainless steel braided hose with isolation ball valves as required.
  - 2) Panel manufacture shall provide all necessary inter-connectors, fittings, hanger brackets, installation kits, pipe headers, accessories, 1" flexible unicellular (foam insulation), and any other components as required for a complete radiant panel system.

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2. Linear Radiant Panels

- a. Linear radiant panels shall use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face. The linear radiant panel is to radiate or absorb heat from or to the zone below.
- b. Water Tubes: Tubes shall consist of ASTM B75 1/2" nominal copper tubing. Water connections shall be one end only. Water connections shall be suitable for solder, compression fittings, push-on fittings or threaded connection.
- c. Heat Sinks: Heat sinks shall be extruded aluminum and copper pipe will be mechanically fastened to the heat sink. A non-hardening heat transfer paste is required between the tubing and the heat sink.
- d. Extruded Aluminum Plank: The panel shall be constructed of 1.2 mm thick extruded aluminum
- e. Paint Finish: All visible components shall be powdercoated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Manufacturer shall provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN 14037 (heating) and DIN 14240 (cooling).
- f. Color to be chosen by Architect.
- g. Linear radiant panel capacity shall be tested and certified by manufacturer in accordance with DIN 14037 (heating) and DIN 14240 (cooling) to meet the performance listed on the schedule. Should any performance rating, chilled water supply temperature, water pressure drop, percentage of glycol, GPM or delta T deviate from the schedule, manufacturer shall submit updated capacity as described in Section 1.3, as well as computational fluid dynamic modeling demonstrating that any changes do not impact the air distribution in a room that would cause a detriment to the PMV and ADPI rating from the design conditions. Manufacturer shall have factory testing facility available to perform performance test of units in accordance with said standard, as required. Upon request, up to 1% of units for the project can be tested in accordance with the standard. Request will be made with order and prior to shipment of chilled sails. Engineer will have the option of witnessing this test.
- h. Water connections shall be shipped sealed to limit the introduction of dust and dirt during shipping and construction.
- i. Accessories:
  - 1) Manufacture shall supply upon request 12"/18" stainless steel braided hose with isolation ball valves as required.
  - 2) Panel manufacturer shall provide all necessary inter-connectors, fittings, hanger brackets, installation kits, pipe headers, accessories, 1: flexible unicellular (foam insulation), trimmable panels, end caps for a continuous look wall to wall and any other component as required for a complete radiant panel system.

3. Approved Manufacturers:

- a. Rittling

- b. Sterling
- c. TWA
- d. Or Equal

F. Light Shelf Radiant Heating Panels

1. Light Shelf Radiant Panels
2. Linear radiant panels shall use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face. The linear radiant panel is to radiate or absorb heat from or to the zone below.
3. Water Tubes: Tubes shall consist of ASTM B75 5/8" nominal copper tubing. Water connections shall be one end only. Water connections shall be suitable for solder, compression fittings, push-on fittings or threaded connection.
4. Heat Sinks: Heat sinks shall be extruded aluminum and copper pipe will be mechanically fastened to the heat sink. A non-hardening heat transfer paste is required between the tubing and the heat sink.
5. Extruded Aluminum Plank: Panels shall be interlocked using tongue & groove connections and be held together using aluminum or steel cross channels with spring clips. The panels shall be installed utilizing the concealed method. The panel shall be constructed of a minimum 1.2 mm thick extruded aluminum with a castellated face finish and corner profile.
6. Paint Finish: All visible components shall be powdercoated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Manufacturer shall provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN 14037 (heating) and DIN 14240 (cooling).
7. Standard Color: color to be chosen by the architect, provide sample selection chart.
8. Light shelf radiant panel capacity shall be tested and certified by manufacturer in accordance with DIN 14037 (heating) and DIN 14240 (cooling) to meet the performance listed on the schedule. Should any performance rating, hot water supply temperature, water pressure drop, etc. deviate from the schedule, manufacturer shall submit updated capacity as described in Section 1.3, as well as computational fluid dynamic modeling demonstrating that any changes do not impact the air distribution in a room that would cause a detriment to the PMV and ADPI rating from the design conditions. Manufacturer shall have factory testing facility available to perform performance test of units in accordance with said standard, as required. Upon request, up to 1% of units for the project can be tested in accordance with the standard. Request will be made with order and prior to shipment of chilled sails. Engineer will have the option of witnessing this test.
9. Water connections shall be shipped sealed to limit the introduction of dust and dirt during shipping and construction.
10. Accessories:
  - a. Manufacturer shall supply upon request 12"/18" stainless steel braided hose with isolation ball valves as required.

11. Panel manufacturer shall provide all necessary inter-connectors, fitting, hanger brackets, installation kits, pipe headers, accessories, 1" foil-back insulation, trimmable panels, mounting arm for installation and any other unit components as required for a complete radiant system.
12. Approved Manufacturers:
  - a. Price
  - b. TWA
  - c. Sterling
  - d. Or Equal

G. Wall Radiation Units

1. General: Provide steel double panel radiators of the lengths and in locations as indicated, and of capacities, style and having accessories as scheduled. The double heating panel radiation shall be of one-piece all-welded steel construction, consisting of a pair of flattened water tube panels welded to headers at each end. Welded to the inside of each panel shall be steel corrugated fins to increase the convective output of the radiator. The fins shall start at no less than 3" from the end of the radiator, and shall have no less than 32 fins per foot. A third set of fins shall be added to the backside of the radiator for maximum convective output. The radiators shall include an integral heavy gauge (0.09" minimum) all-welded perforated top grille, which will cover the top of all of the finned areas.
2. The headers shall include all necessary inlet, outlet and vent connections as required. Standard connection sizes are 1/2" NPT tapered thread for supply and return piping, and 1/8" for the vent connection. Internal baffling is provided where required for proper water flow.
3. The radiant heating panels shall be available in lengths from 2'-0" to 29'-6" in two inch even increments without the need for splicing. The panel radiation shall be capable of being mounted to typical stud wall construction without additional blocking or strapping. Appropriate wall mounting brackets shall be provided with the radiation.
4. The panel radiation shall be manufactured in the USA.
5. Panel radiation expansion shall not exceed 1/64" per foot of radiation at 215°F. The installer shall provide adequate expansion compensation for each radiator.
6. Finishes: The panel radiation shall be cleaned and phosphatized in preparation for the powder coat finish. The radiation is then finish painted with a gloss powder coat finish, for a total paint thickness of 2-3 mils (0.002" - 0.003"). The color shall be selected by the Architect. Provide ribbed pipe cover trims, finished to match the radiator.
7. Warranty: All radiators are covered by a 5-Year Limited Warranty.
8. Manufacturer: Subject to compliance with requirements, provide flat tube panel radiation as manufactured by:
  - a. Sterling
  - b. Runtal North America, Inc.
  - c. Rittling

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d. Or equal

2.15 TERMINAL HEATING UNITS (ELECTRIC) (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)

A. Electric Propeller Unit Heaters (UH)

1. Materials and Equipment:

a. General: Except as otherwise indicated, provide manufacturer's standard electric propeller unit heater materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for a complete installation.

2. Heating Elements:

a. General: Except as otherwise indicated, provide manufacturer's standard heating elements of types, sizes, capacities, and ratings for duty indicated; consisting of resistance elements in steel sheath with extended fins, or with spirally finned sheath.

b. Heating Capacity: Size elements for indicated fan speed, CFM, room heating load (BTUH), entering air temperature, and electric inputs (watts, voltage, phase).

3. Casings:

a. General: Provide casings braced and reinforced to provide required stiffness, and with adjustable heating element supports and brackets. Provide rounded corners. Phosphatize and paint casings inside and out with single coat of baked-on enamel; and zinc plate hardware. Include fan orifice (venturi) in casing, as well as threaded hanger connections (weld nuts). Fabricate from 18-gage galvanized steel.

4. Air Deflectors:

a. General: Provide manufacturer's standard air deflectors of the following types:

- 1) 4-way finned louvers.
- 2) Cone diffusers.
- 3) Vane outlets.
- 4) Louver outlets.

5. Motors:

a. General: Provide totally enclosed shaded-pole, or permanent-split capacitor motors, Class "B" insulation, resiliently mounted, tap wound with built-in thermal overload protection, and with sleeve type or permanently lubricated ball bearings.

b. Internal Electrical Wiring: Provide units with high temperature, heat-resistant electrical wiring enclosed in flexible metal conduit extending from terminal junction box to electrical devices. Provide fusing for motor and control circuit wiring.

c. Devices: Provide propeller unit heaters with the following devices:

- 1) Thermally activated fan switch to keep fan motor operating until residual heat is dissipated.



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- 2) Disconnect switch.
  - 3) Automatic reset, high limit cut-out switch located in discharge air stream.
  - 4) Magnetic contractor.
  - 5) Transformer.
6. Fans:
- a. General: Provide aluminum propeller fans which are balanced statically and dynamically, of indicated capacity. Provide fans suitable for standard or sparkproof application.
7. Manufacturers: Subject to compliance with requirements, provide propeller unit heaters of one if the following:
- a. Chromalox Div.; Emerson Electric Co.
  - b. Federal Pacific Electric Co.
  - c. Gould Inc.
  - d. Markel Nuton Div.; Scoville Inc.
  - e. TPI Corporation.
  - f. Qmark
  - g. Or Equal.
- B. Electric Ceiling Heating Panels
1. The electric ceiling heating panel shall be as manufactured by Berko, A Division of Marley Engineered Products, INEECO, Thermal Equipment Sales, or equal. The construction and design shall permit it to be: recessed ceiling mounted with the use of Recessed Mounting Kit, fit into standard or custom designed modules of a T-bar suspended ceiling, or surface mounted with the use of a Surface Mounting Kit. Panels shall include the custom features listed below.
  2. HEATING ASSEMBLY: The heating assembly shall be UL Listed and CSA Certified and shall consist of powdered graphite encapsulated in a plastic laminate with heavy duty copper buss bars running the entire length, backed by 1 inch, 1 pound density high temperature fiberglass insulation to insulate against heat loss to the ceiling and separated from the inside of the panel by a dielectric insulation to assure uniform heat transfer throughout the entire radiating surface of the heater. The rated input shall be: (62.5 watts/sq. ft. with an average temperature of not more than 165 degree F.) or (95 watts/sq. ft. with an average surface temperature of 200 degree F.), to assure long trouble free life. The panel voltage shall be 208V.
  3. WIRING: For connection to the main power supply, the heater shall be completely prewired, with the lead wires housed in a 48 inch length of flexible metal conduit and connector for J-Box mounting. Appropriate wiring diagrams shall appear on the back of the panel.
  4. PANEL ASSEMBLY: The metal heating panel, containing the completely prewired heating assembly, shall be of 22 gauge formed galvanized steel front and 24 gauge formed galvanized steel back. Sides are overlapping front and back panels riveted together.

5. FINISH: The front of the heating panel shall be unique multi-faceted crystalline type surface finished with high temperature silicone paint.
6. SURFACE MOUNTING Surface Mounting Kit shall come in a separate carton which contains: two side frames, two end frames and eight assembly screws. Frame shall be field assembled before installing on ceiling.
7. RECESS MOUNTING Recess Mounting Kit shall come in a separate carton which contains: four frame sections and four corner pieces.

C. Electric Cabinet Unit Heaters

1. Materials and Equipment:
  - a. General: Except as otherwise indicated, provide electric cabinet heater manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
2. Heating Elements:
  - a. General: Except as otherwise indicated, provide manufacturer's standard heating elements of types, sizes, capacities and ratings for duty indicated; consisting of resistance elements enclosed in steel sheath with extended fins, or with spirally finned sheath.
  - b. Electric Heating Capacity: Size elements for indicated fan speed, CFM, room heating load (BTUH), entering air temperature, and electric input (watts, voltage, phase).
3. Cabinets:
  - a. General: Provide cabinets braced and reinforced to provide required stiffness, and with adjustable heating element supports. Provide 1/2" thick, 2 lb. density, glass fiber insulation on interior of front panel. Phosphatize and paint cabinets inside and out with single coat of baked-on primer. Include discharge air grilles in cabinet, die formed with fixed directional louvers. Provide cabinets with removable front panels secured by slide bolt, camlock or Phillip head type screws. Fabricate from 16-gage galvanized steel.
  - b. Cabinet Accessories: Provide manufacturer's standard accessories of the following types; manufacturer's option applies where more than one type is indicated for each accessory.
    - 1) Gaskets for installation between front panel and enclosure; of manufacturer's standard gasket material.
    - 2) Discharge duct collars.
    - 3) Inlet duct collars.
    - 4) Hinged access doors with tamper-proof latches.
    - 5) Disposable air filters, 1" thick.
    - 6) Tamper-proof panel fasteners consisting of either allen head type machine screws, or spanner wrench type operating cam fasteners.
    - 7) Overlap on 3 or 4 sides (as required) for recessed and semi-recessed cabinets to concealing recesses.
  - c. Cabinet Finish: Provide factory finishes of the following:
    - 1) Special finishes of the type indicated.

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- 2) Baked enamel finishes selected from manufacturer's standard colors.
4. Motors:
    - a. General: Provide totally enclosed shaded-pole, or permanent-split capacitor motors, Class "B" insulation, resiliently mounted tap wound with built-in thermal overload protection, and with permanently lubricated type sleeve or ball bearings.
    - b. Extended Motor Oilers: Provide plastic tubes for lubricating motor bearings which are installed beneath grille.
    - c. Motor Controls: Provide multi-speed motor control switch with OFF position, mounted behind access door.
    - d. Internal Electrical Wiring: Provide units with high temperature, electrical heat-resistant wiring in flexible metal conduit from terminal junction box to electrical devices. Provide fusing for motor and control circuit wiring.
    - e. Devices: Provide cabinet heaters with the following devices:
      - 1) Thermally activated fan switch to keep fan motor operating until residual heat is dissipated.
      - 2) Disconnect switch.
      - 3) Automatic reset, high limit cut-out switch located in discharge air stream.
      - 4) Magnetic contractor.
  5. Fans:
    - a. General: Provide double width, double inlet centrifugal fans, which are balanced statically and dynamically, of indicated capacity. Select fans with single or double extended motor shaft, with fan housing and motor fastened as an integral assembly to a motorboard.
  6. Construction:
    - a. Wheels: Talc-filled polypropylene or aluminum.
    - b. Housing: Galvanized steel.
    - c. Motorboard: Galvanized steel.
  7. Vibration Isolation: Provide types and sizes of vibration isolators as recommended by manufacturer.
  8. Manufacturers: Subject to compliance with requirements, provide cabinet heaters of one of the following:
    - a. American Air Filter Co.
    - b. Chromalox Siv.; Emerson Electric Co.
    - c. Federal Pacific Electric Co.
    - d. General Electric Co.
- 2.16 POWER AND GRAVITY VENTILATORS (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)
- A. General: Except as otherwise indicated, provide standard prefabricated power and gravity ventilator units of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation.

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- B. Refer to Division 23 automatic temperature control for control sequence.
- C. Roof Fans (EF)
1. Type: Centrifugal fan, direct or belt driven as scheduled. Provide aluminum, or galvanized steel, weatherproof housings as scheduled. Provide square base to suit roof curb. Provide permanent split-capacitor type motor for direct driven fans; capacitor-start, induction-run type motor for belt driven fans.
  2. Electrical: Provide factory-wired non-fusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor. Provide conduit chase within unit for electrical connection.
  3. Bird Screens: Provide removable bird screens, ½ in. mesh, 16-ga. aluminum or brass wire.
  4. Motor Operated Dampers: Provide louvered dampers with linkage below curb base (maximum of 6 in.). Provide hinged curb access with restraint cable for service.
  5. Finish: Provide two coat 70 percent Kynar/Hylar finish in color selected by Architect. Dry film thickness shall be 1.23 mil. Provide 10 year finish warranty. Submit color selection chart to Architect as part of submittal package.
  6. Manufacturer: Subject to compliance with requirements, provide centrifugal roof ventilators of one of the following:
    - a. Greenheck Fan Corp.
    - b. Cook Co., Loren.
    - c. Twin City
    - d. Or equal
- D. Kitchen Exhaust Fans – Belt Drive Roof Upblast Centrifugal
1. General Description:
    - a. Discharge air directly away from the mounting surface.
    - b. Upblast fan shall be for roof mounted applications.
    - c. Performance capabilities up to 30,000 cubic feet per minute (cfm) and static pressure to 5 inches of water gauge.
    - d. Maximum continuous operating temperature is 400 Fahrenheit (204.4 Celsius).
    - e. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.
  2. Wheel:
    - a. Material Type: Aluminum.
    - b. Non-overloading, backward inclined centrifugal wheel.
    - c. Statically and dynamically balanced in accordance to AMCA Standard 204-05.
    - d. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

3. Motors:
  - a. AC Induction Motor
    - 1) Motor Enclosure: Open drip proof (ODP) - opening in the frame body and or end brackets.
    - 2) Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
    - 3) Mounted on vibration isolators, out of the airstream.
    - 4) For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants.
    - 5) Accessible for maintenance.
    - 6) Provide premium efficiency inverted duty motors for VFD applications (where applicable, refer to schedule and control drawings).
4. Shaft and Bearings:
  - a. Fan Shaft shall be ground and polished solid steel with an anti-corrosive coating.
  - b. Permanently sealed bearings or pillow block ball bearings.
  - c. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
  - d. Bearings are 100 percent factory tested.
  - e. Fan Shaft first critical speed is at least 25 percent over maximum operating speed.
5. Housing:
  - a. Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing. Galvanized material is not acceptable.
  - b. Housing shall have a rigid internal support structure.
  - c. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing.
  - d. Windband to include an integral rolled bead for strength.
  - e. Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable.
  - f. Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb.
  - g. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
  - h. Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it.
6. Vibration Isolation:
  - a. Double studded or pedestal style true isolators.
  - b. No metal to metal contact.

- c. Sized to match the weight of each fan.
  - 7. Disconnect Switches:
    - a. NEMA rated: NEMA 1: indoor application no water. Factory standard.
    - b. Positive electrical shut-off.
    - c. Wired from fan motor to junction box installed within motor compartment.
  - 8. Drive Assembly:
    - a. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
    - b. Belt: Static free and oil resistant.
    - c. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
    - d. Motor pulleys are adjustable for final system balancing.
    - e. Readily accessible for maintenance.
  - 9. Drain Trough:
    - a. Allows for one-point drainage of water, grease, and other residues.
  - 10. Mounting Plate:
    - a. Attached and sealed to the wall prior to installation of unit.
  - 11. Options/Accessories:
    - a. Auto Belt Tensioner:
    - b. Automatic tensioning device that adjusts for the correct belt tension, only for single drives.
  - 12. Manufacturer: Subject to compliance with requirements, provide centrifugal roof ventilators of one of the following:
    - a. Carnes Co., Div. of Wehr Corp.
    - b. Cook Co., Loren.
    - c. Greenheck Fan Corp.
    - d. Penn Ventilator Co., Inc.
    - e. Power Line Fans; Div. of Torin Corp.
    - f. Twin City
    - g. Or equal
- E. Centrifugal In-Line Fans (EF)
- 1. General: Fans shall be of the centrifugal belt or direct driven in-line type. Units shall bear AMCA label.
  - 2. Fan Housing: Shall be of the square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars. Unit shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.
  - 3. Fan Wheel: Shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

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4. Motors: Shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase, and enclosure. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance.
  5. Shafts and Drives: Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing. A NEMA 1 disconnect switch shall be provided, factory wired.
  6. Manufacturer: Subject to compliance with requirements, provide centrifugal in-line fans of one of the following:
    - a. Greenheck Fan Corp.
    - b. Carnes CO., Div. of Wehr Corp.
    - c. Cook Co., Loren.
    - d. Penn Ventilator Co., Inc.
    - e. Power Line Fans; Div. of Torin Corp.
    - f. Or Equal.
- F. Prefabricated Roof Curbs
1. Manufacturer of ventilating unit shall provide his standard 18 in. high roof curb compatible with unit being provided. Curb shall be insulated with min 1" and sloped to allow for level installation of device. Provide all necessary nailers, and cants for a complete installation.
- G. Smoke Exhaust Fans
1. General: Fans shall be of the mixed flow belt or direct driven in-line type. Units shall bear AMCA label for sound and airflow performance, and shall be UL listed for smoke exhaust application.
  2. Fan Housing: Shall be constructed of heavy gauge galvanized steel and shall include duct mounting collars. Unit shall include removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components. Unit shall accommodate structural steel base mounting.
  3. Fan Wheel: Shall be mixed flow type, constructed of steel and shall include a wheel cone carefully matched to the inlet cone, spherical back plate and cambered blades for precise running tolerances. Wheels shall be statically and dynamically balanced to grade G6.3 per ANSI 52.19.
  4. Motors: Shall allow field rotatable motor position. Shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase, and enclosure. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance.

5. Shafts and Drives: Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be heavy duty, grease lubricated self aligning ball or roller type selected for a minimum (L50) life in excess of 400,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing. A NEMA 1 disconnect switch shall be provided, factory wired.
  6. Manufacturer: Subject to compliance with requirements, provide centrifugal in-line fans of one of the following:
    - a. Greenheck Fan Corp.
    - b. Twin City
    - c. Cook Co., Loren.
    - d. Or equal
- H. Laboratory Exhaust Fans
1. General
    - a. Base fan performance at standard conditions (density 0.075 Lb/ft<sup>3</sup> ).
    - b. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15 percent of scheduled values.
    - c. Each fan shall be belt driven.
    - d. Fans to be equipped with lifting lugs.
    - e. Fan to be coated steel with a minimum of 4 mils of Hi-Pro Polyester Resin. Color to be gray.
    - f. Fasteners to be stainless steel.
    - g. Fan assembly shall be designed for a minimum of 125 MPH wind loading, without the use of guy wires.
  2. Corrosion Resistant Coating
    - a. All fan and system components (fan, nozzle, wind band, plenum) shall be corrosion resistant coated with LabCoat™, a two part electrostatically applied and baked, sustainable, corrosion resistant coating system; or Heresite P-413C. Standard finish color to be gray.
    - b. All parts shall be cleaned and chemically prepared for coating using a multi-stage wash system which includes acid pickling that removes oxide, increases surface area, and improves coating bond to the substrate.
    - c. The first powder coat applied over the prepared surface shall be a zinc rich epoxy primer (no less than 70 percent zinc) and heated to a gelatinous consistency (partial cure) at which the second powder coat of polyester resin shall be electrostatically applied and simultaneously be cured at a uniform temperature of 400 deg.F.
    - d. The coating system shall not be less than a total thickness of 6 mils, is not affected by the UV component of sunlight (does not chalk), and has superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4000 hour ASTM B117 Salt Spray Resistance.



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- e. Note that 10-20 mil thick wet coating systems pollute the environment (air and water), and that these manually applied coatings are not uniform over the impeller surface and can cause fan imbalance and vibration.
3. Fan Housing And Outlet
- a. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
  - b. Fan housing shall be welded steel with a minimum of 4 mils of Hi-Pro Polyester Resin. No uncoated metal fan parts shall be acceptable.
  - c. Fan housings that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel, have rough interior surfaces in which corrosive, hazardous compounds can collect, and / or which chalk and structurally degrade due to the UV component of the sunlight shall not be acceptable.
  - d. A high velocity conical discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
  - e. Provide housing drain for removal of rain and condensation.
  - f. A bolted and gasketed access door shall be supplied in the fan housing allowing for impeller inspection or removal of impeller, shaft and bearings without removal of the fan housing.
  - g. Standard finish color to be gray.
4. Fan Impeller
- a. Fan impeller shall be centrifugal, backward inclined, with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically per AMCA Standard 204.
  - b. Fan impeller shall be manufactured of aluminum (AMCA type B spark resistant), fully welded and meet specification section 2.15 for corrosion resistant coating.
5. Fan Bypass Air Plenum
- a. For constant volume systems, the fan shall be connected directly to the exhaust duct without the need of a bypass air plenum.
  - b. For variable volume systems, a bypass air plenum shall be provided. The plenum shall be equipped with a bypass air damper and intake air hood with bird screen for introducing outside air at roof level upstream of the fan.
  - c. The plenum shall be constructed of fully welded steel, meet specification section 2.15 for corrosion resistant coating, and mount on roof curb as shown on the project drawings. Plenums that are fabricated of plastics or resins that are combustible and have mechanical properties less than steel shall not be acceptable.
  - d. The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer, as shown on the project drawings (see section 2.5)
  - e. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be accepted.

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- f. Bypass air dampers shall be opposed-blade design, and coated with a minimum of 4 mils of Hi-Pro Polyester resin, electrostatically applied and baked.
  - g. A fan isolation damper, either gravity back draft or two position actuated, fabricated of steel or aluminum and coated with minimum 4 mils of Hi-Pro Polyester resin, electrostatically applied and baked, shall be provided as shown on the project documents.
  - h. Blower / Plenum vibration isolation shall be limited to neoprene / cork vibration pads.
6. Bypass Air Plenum Curb
- a. Exhaust system manufacturer shall supply a structural support curb for the plenum, of specified height, as shown on the drawings.
  - b. Curb shall be fabricated of a minimum of 12 gauge corrosion resistant coated steel and structurally reinforced.
  - c. Curbs shall be insulated.
  - d. When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand wind loads of up to 125 mph without additional structural support.
7. Fan Motors And Drive
- a. Motors to be premium efficiency, standard NEMA frame, TEFC with a 1.15 service factor. A factory mounted NEMA 3R disconnect switch shall be provided for each fan. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.
  - b. Drive belts and sheaves shall be sized for 200 percent of the motor horsepower, and shall be readily and easily accessible for service, if required. Drive shall consist of a minimum of two belts under all circumstances.
  - c. Shaft to be polished and ground steel.
  - d. Fan shaft bearings shall be Air Handling Quality, ball or roller pillow block type and be sized for an L-10 life of no less than 100,000 hours. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
  - e. All shaft bearings shall have extended lube lines with zerk fittings.
8. Installation
- a. Install fans with flexible electrical leads.
  - b. Pipe housing drain to nearest drain.
  - c. Install fans in accordance with manufacturer's instructions.
9. Acceptable Manufacturers
- a. Greenheck Fan Corp, Model Vektor High Plume Laboratory Exhaust System (as scheduled)
  - b. Strobic Air
  - c. MK Plastics
  - d. Approved equal.

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- I. Penthouse Elevator Ventilator
1. Type: Penthouse style gravity ventilator with louvers on three sides and breakable glass on the remaining side. Vent shall be sized to comply with the Massachusetts Elevator Code.
  2. Smoke Damper: Provide a sheetmetal damper rated for smoke duty in the throat of the unit. The damper shall be rated for leakage Class 1. The actuator shall be 120V, fail open with open-closed indicator.
  3. Louvers: Louvers shall be heavy gauge extruded stationary louvers constructed of 6063-T5 aluminum of 0.081 in. thickness. Louver shall be 4 in. deep. Louvers shall have a removable bird screen panel mounted on the inside face of the louver. The aluminum bird screen shall be 3/4 in. flattened, expanded mesh of 0.051 in. thickness.
  4. Glass: Glass panel shall be 0.125 in. thick annealed clear breakable glass.
  5. Hood: Hood shall be 38 in. x 38 in. x 18 in. high. Hood shall be constructed of 0.100 thick formed aluminum insulated with 0.5 in. duct liner with an anti-microbial coating.
  6. Curb: Curb shall be constructed of 12 gauge cold rolled steel of welded construction with a 4 in. mounting flange.
  7. Finish: Penthouse vent and curb to be provided with a two coat 70 percent Kynar/Hylar finish in color selected by Architect. Dry film thickness shall be 1.2 mil. Provide ten year finish warranty. Submit color selection chart to Architect as part of submittal package.
  8. Manufacturer: Subject to compliance with specifications herewithin, acceptable manufacturers include: Greenheck Model PEV-400 or equal.

2.17 METAL DUCTWORK (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)

- A. Reference Standards: Material, construction and installation shall meet requirements of most recent editions of the following standards and references, except for more stringent requirements specified or shown on Drawings:

Standard As Applicable To:

SMACNA HVAC Duct Sheet Metal Ductwork;  
Construction Standards Duct Liners; Adhesives;  
Metal and Flexible Fasteners; Flexible Ductwork.

SMACNA HVAC Air Duct Leakage Duct Leakage Testing  
Test Manual

SMACNA Fibrous Glass Duct Fibrous Glass Ductwork; Tapes  
Construction Standards

SMACNA Thermaoplastic Duct (PVC) PVC Ductwork  
Construction Manual

ADC and TIMA Flexible Duct Flexible Ductwork  
Performance Standards

NFPA 96 Kitchen Hood Exhaust Ductwork

NFPA 45 Laboratories using chemicals

SMACNA Guidelines for Welding Welded Galvanized, Black Iron  
 Sheet Metal and Stainless Steel Ductwork

B. General

1. Provide supporting and hanging devices necessary to attach entire HVAC system including ductwork and equipment, and to prevent vibration.
2. Provide vertical and horizontal supports as required by codes to meet minimum applicable earthquake resistance standards.
3. Ductwork shall be free from vibration under all conditions of operation. Dimensions shown on Drawings for lined ductwork are net inside dimensions. Increase ductwork to accommodate lining requirements.
4. Pipe or conduit crossing duct:
  - a. No pipe, conduit, hanger, Architectural element nor structural member shall pass through duct without Designer 's written approval.
  - b. Where it is impossible to re route pipe or conduit and when written approval has been obtained, increase duct size to maintain constant cross sectional area at point of interference. Provide streamlined enclosure for pipe or conduit, as illustrated in SMACNA.
5. When making offsets and transformations necessary to accommodate structural conditions, preserve full cross sectional area of ductwork shown on Drawings.
6. Ductwork shall have pressure velocity classifications as follow:

DUCT CONSTRUCT- ION CLASS	STATIC PRESSURE RATING	PRESSURE	SMACNA SEAL CLASS	SMACNA LEAKAGE CLASS	VELOCITY
4"	4"	Pos.*	A	3	4000 fpm or less
3"	3"	Pos. or Neg.	A	3	4000 fpm or less
2"	2"	Pos. or Neg.	A	6	2500 fpm or less
1"	1"	Pos. or Neg.	A	6	2500 fpm or less
½"	½"	Pos. or Neg.	A	6	2000 fpm or less

\*for negative pressures over 3" w.g., refer to SMACNA Round and Rectangular Industrial Duct Construction Standards for joint and intermediate reinforcement requirements.

7. Ductwork shall have pressure velocity classifications as follow:

DUCT CONSTRUCT- ION CLASS	STATIC PRESSURE RATING	PRESSURE	SMACNA SEAL CLASS	SMACNA LEAKAGE CLASS	VELOCITY
4"	4"	Pos.*	A	6	4000 fpm or less
3"	3"	Pos. or Neg.	A	6	4000 fpm or less
2"	2"	Pos. or Neg.	B	12	2500 fpm or less
1"	1"	Pos. or Neg.	B	12	2500 fpm or less
½"	½"	Pos. or Neg.	B	12	2000 fpm or less

\*for negative pressures over 3" w.g., refer to SMACNA Round and Rectangular Industrial Duct Construction Standards for joint and intermediate reinforcement requirements.

- a. Unless otherwise specified or shown on the drawings, the following pressure classifications shall be used for the types of ductwork listed below:
  - 1) 4" Class: All supply ductwork from discharge of rooftop units to inlets of induction units, displacement diffusers and duct mounted or ceiling mounted diffusers.
  - 2) 3" Class: All kitchen hood exhaust, all return ductwork, kiln exhaust and chemical cabinet ductwork.
  - 3) 2" Class: All other ductwork.
- 8. Sealing Requirements for Class A, Leakage Class 3, Galvanized, Non-Welded Aluminum or Non-Welded Stainless Steel Ductwork:
  - a. Transverse Joints
    - 1) During assembly seal all flanged transverse joints with sealing tape of quality equal to Hardcast Inc. 1902-FR. Corners shall be sealed as described by SMACNA and when applicable per manufacturer's published procedures. After sealant has cured, seal entire joint with Hardcast Inc. RTA-50 adhesive on to Hardcast Inc. DT tape or approved equal.
    - 2) Seal all non-flanged transverse joints with Hardcast Inc. RTA-50 adhesive on to Hardcast Inc. DT tape or approved equal.
  - b. Longitudinal Seams
    - 1) Seal all longitudinal seams during ductwork fabrication with Hardcast Inc. Cold Seal 1001 or approved equal.

- c. Joints and Ductwall Penetrations
  - 1) Seal all duct joints at takeoffs, access doors, damper bearing penetrations, flexible duct connections, seams, elbows, Tee's and any fitting with Hardcast Inc. Versa Grip 102 or approved equal.
  - 2) Note, access doors and damper rod penetrations shall be equipped with proper hardware for sealing.
- 9. Sealing Requirements for Class A, Leakage Class 6, Galvanized, Non-Welded Aluminum or Non-Welded Stainless Steel Ductwork.
  - a. Transverse Joints
    - 1) During assembly seal all flanged transverse joints with sealing tape of quality equal to Hardcast Inc. 1902-FR. Corners shall be sealed as described by SMACNA and when applicable per manufacturer's published procedures.
    - 2) Seal all non-flanged transverse joints with Hardcast Inc. Versa Grip 102 or approved equal.
  - b. Longitudinal Seams
    - 1) Seal all longitudinal seams during ductwork fabrication with Hardcast Inc. Cold Seal 1001 or approved equal.
  - c. Joints and Ductwall Penetrations
    - 1) Seal all duct joints at takeoffs, access doors, damper bearing penetrations, flexible duct connections, seams, elbows, Tee's and any fitting with Hardcast Inc. Versa Grip 102 or approved equal.
- 10. Sealing Requirements for Class B, Leakage Class 12, Galvanized, Non-Welded Aluminum or Non-Welded Stainless Steel, Ductwork.
  - a. Transverse Joints
    - 1) During assembly seal all flanged transverse joints with sealing tape of quality equal to Hardcast Inc. 1902-FR. Corners shall be sealed as described by SMACNA and when applicable per manufacturer's published procedures.
    - 2) Seal all non-flanged transverse joints with Hardcast Inc. Versa Grip 102 or approved equal.
  - b. Longitudinal Seams
    - 1) Seal all longitudinal seams during ductwork fabrication with Hardcast Inc. Cold Seal 1001 or approved equal.
- 11. Support
  - a. Space hangers as required by SMACNA (8 ft max) for horizontal duct on 8 ft. centers, unless concentrated loadings require closer spacing.
  - b. Support vertical duct on each floor or slab it penetrates.
  - c. Supports for ductwork and equipment shall be galvanized unless specified otherwise.

12. Connections

- a. Connect inlets and outlets of air handling units and fans to ductwork with flexible connections unless fan has vibration isolator mounts inside unit with flexible connections and no external vibration isolators. Exception: Do not use flex on life safety smoke exhaust fans.
- b. Indoors, flexible connections shall be neoprene coated fibrous glass fire retardant fabric, by Ventfabrics, or Durodyne. Outdoors, flexible connections shall be Dupont hypalon coated fibrous glass fire, weather, and UV resistant by Ventfabrics or Durodyne.
- c. Secure flexible connections tightly to air handlers with metal bands. Bands shall be same material as duct construction.
- d. Connections from trunk to branch ducts shall be as detailed on Drawings.

13. Construction

- a. No sharp metal edges shall extend into air streams.
- b. Install drive slips on air leaving side of duct with sheet metal screws on 6" centers.
- c. Spin in collars shall NOT be used for branch connections in 3" or higher pressure class ductwork.

14. Joints

- a. Longitudinal lock seams shall be double locked and flattened to make tight joints.
- b. Make transverse joints, field connections, collar attachments and flexible connections to ducts and equipment with sheet metal screws or bolts and nuts. Do not use rivets and staples.

15. Prefabricated Transverse Duct Joints

- a. Transverse joints in galvanized sheet metal ductwork may be made with galvanized gasketed frame and angle duct joint system by Ductmate, TDF, TDC or approved equal. Angles shall be at least 20 gauge. Prefabricated transverse duct joints shall not be used for duct 16 GA. and heavier, nor for duct 23 GA. or lighter.
- b. Secure angles to duct with screws (using clutched arbor) or spot welds spaced as recommended by manufacturer for duct pressure class.

16. Elbows and Bends

- a. Elbows and bends for rectangular ducts shall have centerline radius of 1 1/2 times duct width wherever possible. Elbows for grease exhaust and fume hood exhaust shall be full radius. Vanes or mitered duct are not allowed.
- b. Where centerline radius is less than 1 1/2 times duct width (on supply, return and exhaust ductwork), elbows shall be radius throat (square throat allowed when turning around column or other close objects) with radius heel. For elbows whose width is greater than 48 inches and/or where shown on plans, provide splitter vanes. Install vanes in accordance with SMACNA. Where multiple elbows are separated by less than ten duct diameters use splitter (full length) vanes.

- c. For round ductwork provide stamped elbows, with centerline radii equal to 1 1/2 times duct diameter, or gored elbows as follows:

<b>Elbow Angle</b>	<b>No. of Gores</b>
0° - 36°	2
37° - 72°	3
73° - 90°	5

- d. Elbows for flat oval ducts shall have centerline radii equal to 1 1/2 times duct diameter in plane of bend, or gored elbows with gores as specified for round ducts.

17. Access Panels/Doors

- a. Provide proper pressure and leakage rated, gasketed, duct mounted access panels/doors for the following items with minimum sizes, as indicated. Access doors shall be of double wall construction doors in insulated ducts shall be insulated. Gauges of door materials, no. of hinges, no. and type of door locks shall be as required by the SMACNA Duct Construction Standards. Hinged doors are not acceptable, screwed or bolted access panels are not acceptable. Doors shall be chained to frame with a minimum length of 6" to prevent loss of door. For seal Class A, access doors shall be leakage rated, neoprene gasketed UL 94 HF1 listed, DUCTMATE "sandwich" or approved equal. Door metal shall be the same as the attached duct material. For grease and high temperature ducts, door assembly shall be rated for 2300°F. The minimum sizes are:

- 1) Fire dampers 12" x 12", or larger.
- 2) Combination Fire/Smoke dampers 12" x 12", or larger.
- 3) Smoke dampers 6" x 6" minimum.
- 4) Automatic control dampers 6" x 6" minimum.
- 5) Manual volume dampers 2 sq. ft. and larger 6" x 6" minimum.
- 6) Inlet side to all coils 12" x 12", or larger.
- 7) Suction and discharge sides of inline fans 24" x 24" minimum.
- 8) At additional locations indicated on drawings, or specified elsewhere 12" x 12" minimum.

- b. Generally access doors are not shown on the drawings, but shall be provided in accordance with the above.

18. Extractors shall have adjusting rod and locknut on outside of duct.

19. Connections to roof fans:

- a. Shall be at least 22 ga. galvanized steel soldered watertight.
- b. Solder side seams at least 12" up from bottom.
- c. Provide suitable dielectric gaskets to join dissimilar materials.

20. Plenums and connections to louvers:

- a. Shall be 18 ga. minimum cross broken and properly reinforced with galvanized angle irons to SMACNA requirements.



- b. Shall have bottom and corner seams soldered watertight at least 12" up from bottom.
  - c. Shall have neoprene gaskets or other non corrosible material to make connections to louvers watertight.
  - d. Shall pitch connection back towards the louver. Provide half coupling drain connection at bottom of plenum unless noted otherwise Pipe drain to nearest floor drain.
  - e. Shall have unused portions of louvers blocked-off with sheet metal; sealed air and water tight; insulated with 2" thick 6 lb. density rigid or board insulation.
21. Duct Pressure Tests
- a. Pressure test all duct classes after takeoffs and wall penetrations are in place and before applying exterior insulation. Correct any leaks.
  - b. Pressure and leak test 100% of all duct work with a pressure class of 3" or higher as specified in paragraph 2.18.B.7.a. Duct shall be constructed so there is no joint or structural failure at the test pressure.
22. Duct Leakage Tests
- a. Leak testing method shall be performed as outlined in the SMACNA HVAC Air Duct Leakage Test Manual. As specified in paragraph 2.17.B.7 & a, utilize Sealing Requirements for Class A and Leakage Class 6. Provide orifice assembly including straightening vanes, orifice plate mounted in straight tube with properly located pressure taps, and U tube manometer or other device as specified by SMACNA. Orifice assembly shall be calibrated accurately and shall come with calibration curve. Leakage classes shall be as previously specified. Submit leak test report (per SMACNA format) for Designer review. Drawings of ductwork tested shall also be submitted with report, indicating presence of takeoffs, wall penetrations, joints, etc.
23. Materials
- a. Sheet metal ducts shall be constructed of hot dipped galvanized sheet metal with G90 Commercial coating according to ASTM 527 unless specified otherwise.
  - b. Stainless steel (SS) ductwork shall be 18 gauge for kitchen hoods; and as required by SMACNA for other ducts. Materials shall be 316/No. 4 finish for exposed duct, 304/No. 1 finish for concealed ducts. Joints and seams shall be welded as required by SMACNA Guidelines for Welding Sheetmetal.
  - c. Aluminum ductwork for dishwashers, toilet rooms with showers, shower areas and locker rooms shall be Alclad 3003 1414 or alloy 5052 H32, of thickness required by the SMACNA duct construction standards with Alloy 6061 bracing angles, and Pittsburgh lock longitudinal corner and double side seaming. Pitch ductwork back to dishwasher/grilles.

d. Flexible Ductwork

- 1) Flexible ductwork, connecting to uninsulated or unlined duct, shall be polyester core with corrosion resistant helical wire reinforcing. The polyester core shall be minimum two ply and shall have a minimum thickness of 0.0017". Flex duct shall be U.L. rated for 6" W.C. positive pressure, 2" W.C. negative pressure with a maximum velocity of 4000 FPM. Flexduct must be listed as a Class 1 Connector according to UL 181 and shall meet the requirements of NFPA 90A maximum ASTM E 84 fire hazard rating shall be 25 flame spread, 50 fuel contributed and 50 smoke developed. Uninsulated flexible duct shall be equivalent to Wiremold, Type WB, or Flexmaster Types 2 and 4 (not type 9).
- 2) Flexible duct connected to insulated or lined duct shall also be insulated and shall be equivalent to Wiremold Type WK or Flexmaster Types 2 or 4 (not type 9), with 1 1/2", 3/4 lb. density fiberglass insulation and an aluminized reinforced vapor barrier.
- 3) Submittals shall include data on no. of polyester plies and minimum thickness of polyester core, in addition to other data listed above required to ensure that submitted product meets the requirements of these specifications.
- 4) If flexduct other than the model numbers of the vendors listed above is submitted, a sample of the flex shall be submitted to the Designer. The Designer shall have sole discretion in determining whether the submitted flex is equivalent to that of the named vendors above.
- 5) Unless otherwise indicated, flexible duct shall not exceed 5'-0" long.

e. Rigid PVC ductwork shall be thermally formed ASTM D 1784 69 Class 12454 B with 3/16" thick wall.

C. 2" and Lower Pressure Class Ductwork, Rectangular:

1. Ducts wider than 19" with more than 10 square feet of unbraced panel shall be beaded or cross broken.
2. Internal stiffening struts shall only be used upon prior written approval of the Designer.
3. Make changes in duct size with tapered connections as required by SMACNA. Changes shall NOT exceed 30° from line of air flow. Take off to the diffusers shall be 45° leading edge type or Bellmouth type.
4. Transverse joints shall be TDF/TDC or slip joints; use flat or standing seam according to SMACNA. Where duct size requires standing seam but space restrictions dictate flat seam, notify Designer prior to fabrication.

D. 2" and Lower Pressure Class Ductwork, Round:

1. Joints
  - a. Longitudinal joints shall be spiral seam, butt welded, lap and seam welded, or ACME lock grooved seam. Snap lock seams shall be used on 1/2" w.g. pressure class duct only.
  - b. Transverse joints shall be beaded sleeve joint or other approved joints listed in SMACNA. Use three or more sheet metal screws at 15" uniform intervals along circumference of joints.

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2. Branch fittings shall be conical tee (Buckley or equal) or combination tee as shown in SMACNA.
- E. 3" and 4" Pressure Class Ductwork Rectangular
1. Joints
    - a. Joints shall be prefabricated type by TDC, TDF or Ductmate. See Prefabricated Joints paragraph for specific requirements.
    2. Duct reinforcement spacing and type shall comply with SMACNA.
    3. Ductwork on both sides of transitions shall be run in same horizontal axis.
    4. Diverging section slope shall be 1 1/2" per foot or less if possible.
    5. Contraction section slope shall not exceed 7" per foot.
    6. Takeoffs shall be 45° leading edge type except that Bellmouths (Buckley or equal) may be used for takeoffs to terminal boxes if the distance between the box and point of takeoff is less than 8 ft.
    7. Ducts with an aspect ratio greater than 3:1 shall be minimum of 18 gauge unless a thicker gauge is required by SMACNA.
- F. 3" and 4" Pressure Class Ductwork, Flat Oval, Single Wall
1. Joints
    - a. Ducts shall have spiral lock seams or longitudinal seams. Seams and joints in fittings shall be continuously welded. If coating is damaged during welding, repair joints to prevent corrosion.
    - b. Transverse joints shall be slip or flanged.
- G. 3" and 4" Pressure Class Ductwork, Round, Single Wall
1. Joints
    - a. Longitudinal seams shall be lock spiral, lock longitudinal or butt welded longitudinal.
    - b. Transverse joints shall be slip joints. Draw band joints shall be used on longitudinal seam duct only. Loose flange Vanstone joints may be used on ducts over 36" in diameter.
    - c. Seams and joints in fittings shall be continuously welded. If coating is damaged during welding, repair joints to prevent corrosion.
  2. Branch fittings shall be conical tee or combination tee as detailed in SMACNA.
- H. Double Wall Ductwork
1. Duct and fitting shall be United Sheet Metal Co., Acousti K27, type P or equal consisting of:
    - a. External pressure tight shell of zinc coated steel.
    - b. Uniformly packed, 1-1/2" layer of fire resistant fibrous glass acoustic insulation with R-6 value with mylar or foil liner meeting 25/50 flame spread/smoke developed rating.
    - c. Internal perforated protective metal liner of zinc coated steel, with holes sized and spaced to give acoustic impedance of noise reduction characteristic of Acousti K27 duct.

2. Pressure shell of round duct shall be United or approved equal spiral pipe and pressure shell of fittings shall be zinc coated steel, as follows:

Item	Size	Gauge of Pressure Shell
Duct	3" to 6"	26
	7" to 20"	24
	21" to 34"	22
	36" to 48"	20
Fitting	3" to 34"	20
	36" to 48"	18

3. Fittings shall be continuous, corrosion resistant welds made by certified welders.
4. Joints between straight duct sections shall be made with pre fabricated couplings with 4" shoulder inserted into duct.

I. Flexible Rigid Duct

1. Flexible ductwork shall be Flexmaster Triple Lock Buck Duct Flexible Air Duct (insulated) as manufactured by Buckley Associates or equal (617 878 5000). Flexible duct, non insulated, shall be Underwriters Laboratory Listed UL 181 Class 0 air duct and constructed in accordance with NFPA Standards 90A and 90B. It shall have a smoke/flame spread rating of 50/25.
2. Duct shall be made from a tape of dead soft aluminum sheet, spiral wound into a tube and spiral corrugated to provide strength and stability. The joint shall consist of a triple lock mechanically performed without the use of adhesives to make a durable airtight seam. A double lock is not acceptable.
3. Flexible duct connected to insulated or lined duct shall also be insulated. Flexmaster insulated flex shall have a gray Fire Retardant Polyethylene outer jacket with a ½ lb. density, 1 1/2" thick fiberglass insulation blanket, factory wrapped. Flexible Duct, insulated, shall be Underwriters Laboratory Listed and constructed in accordance with NFPA standards 90A and 90B. It shall have a smoke/flame spread rating of 50/25.
4. The flexible duct shall be supported as required.
5. Flexible duct work shall be rated at 12" positive pressure. Duct from 3 to 16" shall have a negative pressure of 12", 8" for duct work 18 and 20.
6. All flexible duct shall be individually cartoned and labeled for delivery to the job site for maximum protection.
7. Submittals shall include data on minimum thickness of aluminum core, in addition to other data listed above, required to ensure that submitted product meets the requirements of these specifications.
8. Provide sealing compound for installation. See further paragraphs in this specification and details for other installation requirements.

- J. Thermoplastic Ductwork (PVC)
1. PVC duct installation shall be as recommended by SMACNA Thermoplastic (PVC) Duct Construction Manual.
  2. Butt weld longitudinal and transverse joints with hot gas filter rod welding. Rods shall be compatible with material specified for duct. Stagger longitudinal seams. Weld transverse seams on 8 foot centers.
  3. Taper transition pieces 5" in length for each 1" change in diameter.
  4. Provide welded 4" wide reinforcing sleeve straps where recommended by SMACNA.
  5. Provide expansion joints where recommended and as specified by SMACNA.
  6. Provide suitable hangers and supports on eight foot centers that coincide with transverse joints as recommended by SMACNA.
- K. Volume Dampers
1. Provide Young Regulator manual adjustable rectangular opposed blade dampers for duct heights less than 12" with factory installed locking hand quadrants extended 2" for all dampers installed in externally insulated duct:
    - a. On each supply, return and general exhaust duct take off.
    - b. At each take off to register, grille or diffuser (not all are shown on Drawing).
  2. Dampers are manufactured approximately 5/16" smaller in width and 1/8" smaller in height than size of duct in which they are installed; e.g., nominal damper size is 24" x 10"; actual size is approximately 23 11/16" x 9 7/8".
  3. Damper frame shall be constructed of #6063 extruded aluminum reinforced channel with minimum thickness of .050". Opposed damper blades shall be #6063 extruded aluminum with minimum thickness of .050" and shall include reinforcing ribs. Each blade shall be supported in the damper frame by individual Teflon axle bearings, and shall be driven by stainless steel connecting slide linkage controlled by 3/8" square steel control shaft.
  4. Note: All required volume dampers may not be indicated on drawings but dampers shall be provided as necessary for systems balancing.
  5. Dampers 12" and larger in height shall be opposed multi blade equal to Greenheck, Nailor, or Vent Products.
  6. Where dampers are inaccessible, use Young Regulator locking type ceiling regulators and miter gear or worm gear for all horizontal dampers. Bearing coupling for bottom duct control may be used for shaft on vertical blade dampers. The 3/8" rod between ceiling regulator and damper shall be provided by contractor.
  7. Damper blades shall be two gauges heavier than adjoining ductwork, and shall be riveted to supporting rods. Hem over edges parallel to rods.
  8. Brackets shall be galvanized metal, secured to ductwork with sheet metal screw with locking quadrant arms (see seal class section for additional requirements). Provide 2" handle extension for all dampers on externally insulated ductwork.
  9. Note: All required volume dampers may not be indicated on Drawings but dampers shall be provided as necessary for system balancing.

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- L. Automatic Dampers: Install automatic dampers furnished under Automatic Temperature Control Paragraph of this Section, as shown on Drawings, and as specified. Provide sealed wall penetrations for Seal Class A ductwork.
  - M. Locker Room Exhaust or Return Ductwork as well as Dishwasher Exhaust
    1. Ductwork shall be aluminum, of types as detailed in this specification above and constructed in accordance with SMACNA except that Seal Class shall be "A" regardless of duct pressure rating.
  - N. Branch Duct Take off Fittings
    1. Contractor shall provide Buckley Bellmouth Take offs at all branch duct locations.
    2. Bellmouth Fitting shall be Model BMD with damper. In areas where sufficient duct height is not available, the contractor shall provide the Buckley Mini mouth fitting, Model M BMD with damper or the flat oval Bellmouth, Model FOBMD with damper.
    3. Bellmouths shall be constructed of heavy duty galvanized steel. Bellmouths shall include an air tight Neoprene gasket to ensure a tight fitting with minimal leakage. Pre drilled holes shall be provided for quick mounting. Bellmouth shall be as manufactured by Buckley Associates or equal (617 878 5000).
    4. Standard damper hardware to be constructed of 26 gauge galvanized material with a quadrant damper and tight fitting gasketing to ensure minimal leakage at damper pivot points.
    5. Optional heavy duty hardware shall be provided at locations of higher static pressure where shown on the drawings.
    6. Ninety degree take offs are not permitted on this project.
- 2.18 DUCTWORK ACCESSORIES (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)
- A. Dampers:
    1. Low Pressure Manual Dampers: Provide dampers of single blade type or multi-blade type, constructed in accordance with SMACNA "HVAC Duct construction Standards".
    2. Automatic Control Dampers: Refer to Division 23 section "Automatic Temperature Control" for control dampers; not work of this section.
    3. Backdraft Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at .05 in. static pressure. Construct blades of 16-ga. aluminum; provide ½ in. diameter ball bearings, 1/2 in. diameter steel axles spaced on 9 in. centers. Construct from 2 in. x 1/2 in. x 1/8 in. steel channel for face areas 25 sq. ft. and under: 4 in. x 1-1/4 in. x 16 ga. channel for face areas over 25 sq. ft. Provide galvanized steel finish on frame with aluminum touch-up. Provide felted or rubber trim to assure tight, leak-proof seal when closed.
    4. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following:
      - a. Air Balance, Inc.
      - b. Airgarde Corp.

- c. American Warming & Ventilating, Inc.
- d. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
- e. Louvers & Dampers, Inc.
- f. Penn Ventilator Co.
- g. Ruskin Mfg. Co.
- h. Or Equal.

B. Fire Dampers:

1. Fire Dampers: Provide fire dampers, of types and sizes indicated. Construct casings of 11-ga. galvanized steel. Provide fusible link rated at 160 to 165 degrees F (71 to 74 degrees C) unless otherwise indicated. Provide out of air stream type damper in open position and with positive lock in closed position with stainless steel heat treated type 301 closure spring, and with the following additional features:
  - a. Damper Blade Assembly: Curtain type.
  - b. Blade Material: Steel, match casing.
  - c. Blade Material: Stainless steel.
2. Combination Fire/Smoke Dampers: Provide fire/smoke dampers, of types and sizes indicated. Construct casing of 11-ga. galvanized steel with bonded red acrylic enamel finish. Provide fusible link rated at 160 to 165 degrees F (71 to 74 degrees C) unless otherwise indicated. Provide additional frangible link containing explosive charge, connected in series with fusible link. Provide stainless steel spring loaded leakage seals in sides of casing, and 36 in. long wire leads for connecting smoke link to smoke detector, and the following additional features:
  - a. Damper Blade Assembly: Single-blade type.
  - b. Damper Blade Assembly: Multi-blade type.
  - c. Damper Blade Assembly: Curtain type.
  - d. Blade Material: Steel, matching casing.
  - e. Blade material: Stainless steel.
3. Motor-Driven Fire/Smoke Dampers: Provide motor-driven fire/smoke dampers in types and sizes indicated, with casing constructed of 11-ga. galvanized steel with bonded red acrylic enamel finish, fusible link 160 to 165 degrees F (71 to 74 degrees C), unless otherwise indicated, and curtain type stainless steel interlocking blades, with electric motor equipped with instant closure clutch, stainless steel cable damper blade linkage, motor mounting bracket, and 32 in. long wire leads for connecting to smoke detector, and with the following construction features:
  - a. Unit Assembly: Motor mounted outside air stream.
4. Manufacturer: Subject to compliance with requirements, provide fire and smoke dampers of one of the following:
  - a. Air Balance, Inc.
  - b. American Warming & Ventilating, Inc.
  - c. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
  - d. Louvers & Dampers, Inc.

- e. Penn Ventilator Co.
  - f. Phillips-Aires
  - g. Ruskin Mfg. Co.
  - h. Or Equal.
- C. Turning Vanes:
- 1. Manufactured Turning Vanes: Provide double thickness airfoil turning vanes constructed of 1-1/2 in. wide curved blades set at 3/4 in. o.c., supported with bars perpendicular to blades set at 2 in. o.c, and set into side strips suitable for mounting in ductwork.
  - 2. Manufacturer: Subject to compliance with requirements, provide turning vanes of one of the following:
    - a. Aero Dyne Co.
    - b. Airsan Corp.
    - c. Anemostat Products Div.; Dynamics Corp. of America.
    - d. Barber-Colman Co.
    - e. Duro Dyne Corp.
    - f. Environmental Elements Corp.; Subs, Koppers Co., Inc.
    - g. Hart & Cooley Mfg. Co.
    - h. Register & Grille Mfg. Co., Inc.
    - i. Southern, Inc.
    - j. Or Equal.
- D. Duct Hardware:
- 1. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
    - a. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
    - b. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12 in.. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.
  - 2. Manufacturer: Subject to compliance with requirements. Provide duct hardware of one of the following:
    - a. Ventfabrics, Inc.
    - b. Young Regulator Co.
    - c. Or Equal.
- E. Duct Access Doors:
- 1. General: Provide duct access doors of a size as required to service and maintain device in duct. All access doors to be a minimum of 12 in.x12 in. and to be gasketed and installed air tight. Provide one access door at each control damper, humidifier, coil, fire damper, and any device that requires attention.



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2. Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12 in. high and smaller, 2 handle-type latches for larger doors.
  3. Manufacturer: Subject to compliance with requirements, provide duct access doors of one of the following:
    - a. Air Balance, Inc.
    - b. Duro Dyne Corp.
    - c. Register & Grille Mfg. Co., Inc.
    - d. Ruskin Mfg. Co.
    - e. Ventfabrics, Inc.
    - f. Zurn Industries, Inc.; Air Systems Div.
    - g. Or Equal.

F. Flexible Connectors:

1. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.
2. Manufacturer: Subject to compliance with requirements, provide flexible connections of one of the following:
  - a. American/Elgen Co.; Energy Div.
  - b. Duro Dyne Corp.
  - c. Flexaust (The) Co.
  - d. Ventfabrics, Inc.
  - e. Or Equal.

2.19 FABRIC DUCT

A. TEXTILE AIR DISPERSION SYSTEM:

1. Air diffusers shall be constructed with internal frame.
  - a. Textile components supported solely by metal cylindrical rings.
  - b. Each cylindrical ring shall require a vertical metal to metal cable safety attachment.
    - 1) Vertical supports are Galvanized steel with available lengths of 5'(standard), 10', 15', & 30'.
  - c. Available for diameters from 8" – 84".
  - d. Not available for natatorium applications.

B. TEXTILE

1. TufTex
  - a. Textile Construction: Filament/filament twill polyester, fire retardant in accordance with UL 2518.
  - b. Air Permeability: 2 (+2/-1) CFM/ft<sup>2</sup> per ASTM D737, Frazier
  - c. Weight: 6.8 oz. /yd<sup>2</sup> per ASTM D3776
  - d. Warranty: 15 years with standard inlet velocity.
2. Textile Color
  - a. Standard: blue, white, tan, red, green, silver, black
  - b. Custom

C. TEXTILE SYSTEM FABRICATION REQUIREMENTS:

1. Textile system to be constructed in modular lengths (zippered) with proper radial securing clips (inlets, endcaps, and mid-sections) and top access zippers for vertical cable safety attachment.
2. Integrated air dispersion shall be specified and approved by manufacturer.
  - a. Linear Vents
    - 1) Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on .5" SP), starting a 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.
    - 2) Size of vent openings and location of linear vents to be specified and approved by manufacturer.
3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener – supplied by contractor.
4. Inlet connection includes zipper for easy removal / maintenance.
5. Lengths to include required intermediate zippers as specified by manufacturer.
6. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.
7. End cap includes zipper for easy maintenance.
8. Each section of the textile shall include identification labels documenting order number, section diameter, section length, piece number, code certifications and other pertinent information.

D. DESIGN PARAMETERS:

1. Textile air diffusers shall be designed from 0.25" water gage minimum to 3.1" maximum, with 0.5" as the standard.
2. Textile air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).

3. System overall design; diameter, length, airflow, operating static pressure and dispersion shall be designed or approved by the manufacturer.
4. Do not use textile diffusers in concealed locations.
5. Use textile air dispersion systems only for positive pressure air distribution components of the mechanical ventilation system.

E. QUALITY ASSURANCE:

1. Building Codes and Standards:
  - a. Product must be Classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A and UL 2518. Also Classified by UL-C (Canada) S102.2, BS 5867 Part 2, 1980; GB8624-2006.
  - b. All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.
2. Design & Quality Control
  - a. Manufacturer must have documented design support information including duct sizing; vent, orifice, and/or nozzle location; vent, orifice, and/or nozzle sizing; length; and suspension. Parameters for design, including maximum air temperature, velocity, pressure and textile permeability, shall be considered and documented.

F. WARRANTY:

1. Manufacturer must provide a 15 Year Product Warranty for products supplied for the fabric portion of this system as well as a Design and Performance Warranty.

G. MANUFACTURER:

1. Subject to compliance with requirements, choose one of the following:
  - a. DuctSox® Corporation
  - b. FabricAir
  - c. KE Fibretec
  - d. Or equal

2.20 ACOUSTIC DUCT LINING

- A. Lining for Rectangular Metal Ducts: All ducts, where shown or noted on the drawings, shall be lined with 1 ½ in. thick (R-6 min. performance) liner similar to Johns Manville "Linacoustic RC" fiberglass duct liner with factory-applied surface and edge coating. The liner shall meet the Life Safety Standards as established by NFPA 90A and 90B, FHC 25/50 and Limited Combustibility and the airstream surface coating should contain an immobilized, EPA-registered, anti-microbial agent so it will not support microbial growth as tested in accordance with ASTM G21 and G22. The duct liner shall conform to the requirements of ASTM C 1071 and C1104, with an NRC not less than .75 as tested per ASTM C 423 using a Type "A" mounting, and a thermal conductivity no higher than .24 at 75EF mean temperature.

- B. Material Handling and Storage: Liner shall be kept clean and dry during transportation, storage and installation. Care should be taken to protect the liner from exposure to the elements or damage from mechanical abuse.
- C. Manufacturer: Subject to compliance with the above provide duct sound lining in accordance with the above performance criteria description.

## 2.21 SOUND ATTENUATORS (SA)

- A. General: Provide factory-fabricated and tested duct silencers as indicated, select with performance characteristics which match, or exceed those indicated on schedule.
- B. Casings: Construct of sheet metal, with gage and seam construction equal or greater than that recommended by SMACNA-Duct Construction Standards for ductwork of same size and pressure class; but not less than gauge dimension recommended by manufacturer based upon application and acoustic DIL requirements (or 16-gage for outer casing and 22-gage for inner casing).
- C. Acoustic Fill: Provide inorganic mineral or mold blocking cloth lining material, inert, vermin and moisture proof, of sufficient density to obtain specified acoustic performance. Pack under not less than 5 percent compression to eliminate voids due to vibration and settling.
- D. Acoustic Performance: Provide silencer ratings that have been determined in such to reverberative room test facility. Test silencer with air flow in both directions through silencer, in accordance with ASTM E477, "Methods of Testing Duct Liner Materials and Prefabricated Silencers for Acoustical and Airflow Performance."
  - 1. For acoustic ratings, include Dynamic Insertion Loss and Self Noise Power Levels for both forward flow (air and noise in same direction) and reverse flow (air and noise in opposite directions) with airflow of at least 2,000 FPM face velocity.
- E. Aerodynamic Performance: Provide silencers with static pressure loss equal to or less than that scheduled.
- F. Certification: Provide certified test data on Dynamic Insertion Loss, Self-Noise Power Levels, and Aerodynamic Performance. Conduct all rating tests at same facility. Open testing facility for inspection by Architect/Engineer if requested.
- G. Manufacturers: Subject to compliance with requirements, provide duct silencers of one of the following:
  - 1. Vibro-Acoustics
  - 2. Aeroacoustic Corporation
  - 3. Industrial Acoustics Co.
  - 4. Price
  - 5. Or Equal.

2.22 AIR OUTLETS AND INLETS (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)

A. Ceiling Air Diffusers:

1. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation. Stamped face diffusers will not be acceptable.
2. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw, drop and noise criteria ratings for each size device as listed in manufacturer's current data.
3. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
4. Types: Provide ceiling diffusers of type, capacity, throw, blow and with accessories as listed on diffuser schedule.
  - a. Ceiling Diffusers shall be of the restricted multi-orificed jet induction and air mixing type consisting of louver sections with built-in diffusing vanes. The vanes shall be arranged to discharge air from adjacent louvers at an angle of 45 degrees in opposite directions to insure rapid mixing of primary and room air. Diffusing vanes shall be welded and mechanically fastened to the adjacent louver sections to make a rigid unit. The vanes shall extend to the discharge edges of the louvers. Where louver sections join the core frame, the louver ends shall be welded to the core frame. The leaving edge of each louver shall be hemmed and the louver ends shall be rounded and hemmed before welding to the core frames.
  - b. Diffusers shall be fabricated of aluminum or steel-welded construction, and shall be provided with a removable core permitting easy access to the neck connection. The diffuser neck shall extend no less than 1 in. above the core to accommodate an internal duct connection to prevent leakage into the ceiling space.
  - c. Finish shall be baked enamel. Color as selected by architect, provide sample selection chart.
  - d. Plaque diffuser shall be one piece seamless back cone with round inlet color and inner removable plaque assembly.
5. Diffuser Dampers:
  - a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of diffuser. Provide in each ceiling diffuser.
6. Manufacturer: Subject to compliance with requirements, provide diffusers of one of the following:
  - a. Tuttle & Bailey Agitair Series
  - b. Metalaire – "5000 IV"
  - c. Price
  - d. Krueger

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e. Or Equal

B. Wall Registers and Grilles:

1. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
2. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.
3. Compatibility: Provide registers and grilles with border styles that are compatible with adjacent systems, and that are specifically manufactured to fit into wall and ceiling construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of construction which will contain each type of register and grille.
4. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule:
5. Pattern: Register and grille patterns shall have style as identified on Drawings:
6. Dampers: Opposed Blade adjustable assembly, key operated from face of register.
7. Accessories:
  - a. Plaster Frame: Perimeter frame designed to act as plaster stop and register or grille anchor. Provide where required.
  - b. Operating Keys: Tools designed to fit through register or grille face and operate volume control device and/or pattern adjustment.
8. Finish: Register and Grille Finishes shall be baked enamel. Color as selected by architect, provide sample selection chart.
9. Manufacturer: Subject to compliance with requirements, provide registers and grilles of one the following:
  - a. Price
  - b. Tutte & Baliley Agitair (Air Devices)
  - c. Metalaire
  - d. Price
  - e. Krueger
  - f. Or Equal.

C. Ceiling Registers and Grilles:

1. General: Except as otherwise indicated, provide manufacturer's standard "Egg-Crate" type registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
2. Compatibility: Provide registers and ceiling grilles with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling construction.

3. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule.
  4. Register and Grille Materials:
    - a. Aluminum Construction: Manufacturer's standard extruded aluminum frame and core.
  5. Register and Grille Faces:
    - a. 1/2 in. x 1/2 in. "Egg-Crate" with one in. border frame.
  6. Register and Grille Dampers:
    - a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of register (provide for registers only).
  7. Register and Grille Finishes shall be baked enamel. Color as selected by architect, provide sample selection chart.
  8. Manufacturer: Subject to compliance with requirements, provide registers and grilles of one of the following:
  9. Agitair (Air Devices)
    - a. Price
    - b. Metalaire
    - c. Krueger
    - d. Or Equal.
- D. In Wall Displacement Diffuser
1. Description: Furnish and install in wall displacement diffusers with the sizes and capacities indicated on the plans and air outlet schedule.
  2. Performance: Air shall be delivered to the space at low noise levels and low velocities that are even across the diffuser face, in all ducting configurations and without the use of nozzles.
  3. Diffuser Manufacturer shall provide sound and pressure drop data derived from tests in accordance with ASHRAE Standard 70-2006. Performance data for Draft Rate (%DR) shall be provided based on tests in accordance with ASHRAE Standard 55-2004. A manufacturer software program that allows room comfort evaluation for specific operating conditions and diffuser locations shall be available to aid in performance assessment. If such a computer program is not available from the manufacturer, the manufacturer shall supply, free of charge, a CFD model of the representative spaces completed by a modeling contractor who has demonstrable qualifications to model such spaces. These shall include no less than 10 years of experience in the modeling of displacement ventilation systems, thorough validation of the code through comparison to empirical data as well as a list of references.

4. Construction: The 1 way flat faced in-wall displacement diffuser, shall be constructed with an equalization baffle behind the operative diffuser face for uniform, low velocity, distribution of supply air. Both the equalization baffle and face shall be securely retained in the diffuser frames. Plastic nozzle arrays or any plastic components are unacceptable. The diffuser frames shall be constructed of 20 gauge steel for rigidity and protection of the operative face. The operative face shall be constructed of painted 18 gauge perforated steel, and the frame shall be provided in painted 20 gauge steel. The plenum shall be 24 gauge steel. The internal baffling elements shall be constructed of aluminum. The diffuser shall be available for duct connection at the top. The paint shall be powder coat polyester, color as selected by architect, provide sample selection chart. Epoxies and their derivatives are unacceptable. Visible non-metallic components are unacceptable.
5. Mounting/Fastening: The diffuser front panel shall be bolted to the plenum through the wall with factory provided fasteners.
6. Manufacturer: Subject to compliance with requirements, provide flat faced displacement diffusers of one of the following:
  - a. Price
  - b. Metalaire
  - c. Titus
  - d. Or Equal.

E. Flat Face Displacement Diffusers

1. Description: Furnish and install flat face displacement diffuser with the configurations and mounting types indicated on the plans and air outlet schedule.
2. Performance: Air shall be delivered to the space at low noise levels and low velocities that are even across the diffuser face, in all ducting configurations and without the use of nozzles. Diffuser Manufacturer shall provide sound and pressure drop data derived from tests in accordance with ASHRAE Standard 70-2006. Performance data for Draft Rate (%DR) shall be provided based on tests in accordance with ASHRAE Standard 55-2004. A software program that allows room comfort evaluation for specific operating conditions and diffuser locations shall be available to aid in performance assessment. If such a computer program is not available from the manufacturer, the manufacturer shall supply, free of charge, a CFD model of the representative spaces completed by a modeling contractor who has demonstrable qualifications to model such spaces. These shall include no less than 10 years of experience in the modeling of displacement ventilation systems, thorough validation of the code through comparison to empirical data as well as a list of references.



3. Construction: The 1 way flat faced recessed displacement diffuser shall be constructed with an equalization baffle behind the operative diffuser face for uniform, low velocity, distribution of supply air. Both the equalization baffle and face shall be securely retained in the diffuser frames. Plastic nozzle arrays or any plastic components are unacceptable. There shall be no visible fasteners on the front panel. The operative face shall be constructed of painted 18 gauge perforated steel. The installation frame shall be constructed of 24 gage steel. The internal baffling elements shall be constructed of aluminum. The paint shall be powder coat polyester, color as selected by architect, provide sample selection chart.. Epoxies and their derivatives are unacceptable. Visible non-metallic components are unacceptable. The diffuser shall be supplied with an installation frame for recessed installation that is not visible from the room. (The diffuser shall be supplied with an installation frame for recessed installation which allows the diffuser to be installed in areas where plaster is required).
  4. Mounting/Fastening: The diffuser shall be installed within the manufacture provided plenum, refer to details sheet M2.4 for further information. Plenum to be provided with mounting clips, all by diffuser manufacture. The diffuser shall have no visible fasteners or framing, and shall be held within the supplied plenum via secure mounting clips.
  5. Manufacturer: Subject to compliance with requirements, provide flat faced displacement diffusers of one of the following:
    - a. Price
    - b. Metalaire
    - c. Trox
    - d. Krueger
    - e. Or Equal.
- F. Ceiling Mounted Displacement Diffusers
1. Description: Furnish and install ceiling mounted displacement diffuser with the sizes and capacities indicated on the plans and air outlet schedule.
  2. Performance: Air shall be delivered to the space at low noise levels and low velocities that are even across the diffuser face in all ducting configurations and without the use of nozzles. Diffuser Manufacturer shall provide sound and pressure drop data derived from tests in accordance with ASHRAE Standard 70-2006. Performance data for Draft Rate (%DR) shall be provided based on tests in accordance with ASHRAE Standard 55-2004. A manufacturer software program that allows room comfort evaluation for specific operating conditions and diffuser locations shall be available to aid in performance assessment. If such a computer program is not available from the manufacturer, the manufacturer shall supply, free of charge, a CFD model of the representative spaces completed by a modeling contractor who has demonstrable qualifications to model such spaces. These shall include no less than 10 years of experience in the modeling of displacement ventilation systems, thorough validation of the code through comparison to empirical data as well as a list of references.

3. Construction: The 1 way flat faced ceiling mounted Displacement diffuser shall be constructed with an equalization baffle behind the operative diffuser face for uniform, low velocity, distribution of supply air. Both the equalization baffle and face shall be securely retained in the diffuser frames. Plastic nozzle arrays or any plastic components are unacceptable. The diffuser frames shall be constructed of high strength aluminum extrusion for rigidity and protection of the operative face and side panels. There shall be no visible fasteners on the front or side panels. The operative face shall be constructed of painted 18 gauge perforated steel, and the frame shall be provided in painted 20 gauge steel. The internal baffling elements shall be constructed of Aluminum. The diffuser shall be available for duct connection at the top, bottom, side or rear of the diffuser with a factory inlet. The paint shall be powder coat polyester, color as selected by architect, provide sample selection chart. Epoxies and their derivatives are unacceptable. Visible non-metallic components are unacceptable.
4. Mounting/Fastening: The diffuser shall integrate into standard T-Bar ceilings and shall have no visible fasteners.
5. Manufacturer: Subject to compliance with requirements, provide flat faced displacement diffusers of one of the following:
  - a. Price
  - b. Metalaire
  - c. Trox
  - d. Krueger
  - e. Or Equal.

G. Linear Diffusers

1. Linear slot diffusers shall be furnished and installed as indicated on the drawings.
2. Provide shop drawings accompanied by itemized list indicating units' location and appropriate product submittal drawings provided by the manufacturer.
3. Exact dimensions of walls and ceiling are as per the architectural drawings. Install diffusers so they fit properly in the ceiling system with suspension wire (48 in. o/c MAX.) and/or attachment plates — as required.
4. Coordinate installation with General Contractor and other sub-contractors.
5. The linear slot diffuser shall utilize heavy wall extruded aluminum air deflector frames. These frames shall be designed to accommodate notched compressible space bars, complete with integral hanger, spaced approximately 24 in. on center. The steel air pattern controllers are fully adjustable and can be moved from side to side to create various air pattern configurations. These dual pattern controllers shall be fully adjustable to allow shut-off without adding any blank-off devices. The spacer bars and pattern controllers shall be removable for on-site modification and trimming.
6. The Linear slot diffuser shall be complete with factory end conditions as shown or indicated.
7. Supply air engineered plenums shall be provided and manufactured of heavy gauge wipe coat steel. These units shall be insulated with a side inlet collar.

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8. When engineered plenum end caps cannot positioned directly over the linear spacer bar due to field conditions, install MB Blank-Off from plenum end cap to next spacer bar.
  9. MB Blank-Off shall be manufactured of heavy gauge steel painted black.
  10. Linear Bar Grilles: Furnish and install extruded bar supply/return grilles of the sizes and mounting types indicated on the plans and outlet schedule.
    - a. Construction: Grilles shall have fixed degree blades, spaced 7/16 in. on center. The outlet core shall have extruded aluminum receiving bar. Blades shall run parallel to the long dimension of the grille. The grille border shall be heavy duty extruded aluminum construction with factory mitered corners and reinforcing support bars for extra support for the core receiving bar. The support and receiving bars shall not exceed 8 in. on center. The core shall be held into the border with removable core clips allowing the removal of the core without special tools.
    - b. Finish: The grille shall be finished, color as selected by architect, provide sample selection chart. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering as per ASTM D610 and ASTM D714.
    - c. Manufacturer: Subject to compliance with requirements, provide linear bar grilles of one of the following:
      - 1) Agitair
      - 2) Metalaire
      - 3) Price
      - 4) Krueger
      - 5) Or equal

#### 2.23 VARIABLE AIR VOLUME BOX (VAV)

- A. General: Provide factory-fabricated and tested air terminals as shown on drawings, selected with performance characteristics which match or exceed those indicated on schedule.
- B. Casings: Construct of die-cast aluminum or sheet metal of the following minimum thicknesses:

	Steel	Aluminum
1. Upstream Pressure Side:	22-ga.	0.032 in.
2. Downstream Pressure Side;	22-ga.	0.025 in.

  3. Provide hanger brackets for attachment of supports.
  4. Linings: Line inside surfaces of casings with hospital grade lining material meeting ASTM Standard C1071 to provide acoustic performance, thermal insulation, and to prevent condensation on outside surfaces of casing. Provide minimum thickness of 1 in. Secure lining to prevent delamination, sagging or settling. Seal edges of lining to prevent fraying.
    - a. Cover liner surfaces and edges with mylar, foil or perforated metal.

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5. Leakage: Construct casings such that when subjected to 0.5-in w.g. pressure for low pressure units, and 3.0-in w.g. pressure for high pressure units, total leakage does not exceed 4 percent of specified air flow capacity with outlets sealed and inlets wide open. Construct air dampers such that when subjected to 6.0-in w.g. inlet pressure with damper closed, total leakage does not exceed 10 percent of specified air flow capacity.
- C. Air Dampers: Construct of materials that cannot corrode, do not require lubrication, nor require periodic servicing. Provide maximum volume dampers, pressure independent that are calibrated in cfm, factory-adjusted, and marked for specified air capacities. Provide mechanism to vary air volume thru damper from minimum to maximum, in response to signal from thermostat.
  - D. Controls: Provide controls accurate to 1.5 deg. F(0.8 deg. C) and adjustable from 65 deg. F (22 deg. C) to 85 deg. F (29 deg. C).
    1. ATC Contractor to provide and field install DDC controls, compatible with automatic temperature control system specified in other Division-23 sections. All testing and commissioning shall be completed in field.
  - E. Identification: Provide label on each unit indicating Unit Number, cfm range, cfm factory-setting, and calibration curve (if required).
  - F. Silencer:
    1. Silencer section shall consist of a three foot 22ga solid metal casing, 22ga perforated liners, and absorptive acoustic fiberglass liner.
    2. Acceptable methods of silencer construction shall be button lock, Pittsburgh lock, and welds. In situations where these methods are not feasible, rivets can be used. Screws or other mechanical fasteners on the silencer will not be acceptable.
    3. The silencer noses and perforated liners shall be rigidly fastened to the casing of the silencer on both the top and bottom.
    4. The silencer section acoustic media shall be shot free inorganic glass fiber with long, resilient fibers, bonded with thermosetting resin, and contain 50 percent recycled media. Glass fiber shall be packed with a minimum 10 percent compression to eliminate voids and settling; density shall consistent with that used to generate catalog test data. Combustion ratings for acoustical media shall be equal to or less than the combustion ratings noted below when tested in accordance with ASTM E84, UL713, and NFPA 255:
      - a. Flame Spread Classification: 25
      - b. Smoke Development Rating: 50
    5. Silencer shall be Price model SDVQ.
  - G. Manufacturer: Subject to compliance with requirements, provide variable air volume boxes of one of the following:
    1. Price
    2. Metalaire
    3. Nailor
    4. Or equal

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## 2.24 CONSTANT VOLUME DAMPERS

- A. Provide Adjustable Constant Airflow Regulators by American ALDES Ventilation Corporation, or equal. The constant volume dampers shall operate solely on duct pressure and require no external power supply. Each regulator shall be capable of being field adjusted to the required airflow setpoint, as indicated on the schedule, by manual adjustment of the control device using an Allen/Hex key. The device shall be rated for use in air temperatures ranging from -22° to 212°F (-30° to 100°C).
- B. Constant volume dampers shall be capable of maintaining constant airflow within ± 10% for nominal airflow > 60 CFM (100 m<sup>3</sup>/h) and ± 5 CFM (10 m<sup>3</sup>/h) for nominal airflow < 60 CFM (100 m<sup>3</sup>/h) throughout the target operating pressure range of 0.2 to 4.0 in. w.g. (50 to 1000 Pa) differential pressure. Sound power levels shall not exceed those for each size and CFM rating as scheduled.
- C. The device is constructed of a laser-welded, galvanized steel body, a translucent plastic control device, and a double-lip airtightness seal around the circumference to ensure a tight, no-leak fit. The integral control device shall be comprised of an aluminum damper and a stainless steel spring and shaft fitted to PTFE (polytetrafluoroethylene) bearings. A pneumatic piston damper prevents overshoot and oscillation of the control damper and ensures an accurate response and control behavior.
- D. All Adjustable Constant Airflow Regulators will require no maintenance and must be warranted for a period of no less than five (5) years. The Adjustable Constant Airflow Regulators shall be installed in tight ducting systems in accordance with all applicable codes and manufacturer's instructions.

## 2.25 DUCTLESS COOLING UNITS (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)

- A. Evaporator:
  - 1. General: The unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board, and fan motor. The unit in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, three-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from factory.
  - 2. Cabinet: The casing shall be ABS plastic factory finish. Cabinet shall be designed for suspension mounting and horizontal operation. The rear cabinet panel shall have provisions for a field installed filtered outside air intake connection.
  - 3. Fan: The evaporator fan shall have three high performance, double inlet, forward curve sirocco fans driven by a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of four speeds: Low, M1, M2 and Hi.

4. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall provide a choice of five vertical airflow patterns selected by remote control. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.
5. Filter: Return air shall be filtered by means of an easily removable washable filter.
6. Coil: The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.
7. Control: The control system shall consist of two microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. Field wiring shall run directly from the indoor unit to the wall mounted controller with no splices. For A-Control, a three conductor 14 ga. AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. Where separate power is supplied to the indoor and outdoor units, a two 20 ga. AWG wire shall be run between the units to provide forbid-directional control communication. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.

B. Condensing:

1. General: The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions. The outdoor unit shall be capable of operating at 0 degrees F, (-18 degrees C) ambient temperature without additional low ambient controls. The outdoor unit shall be able to operate with a maximum height difference of 100 ft. and have maximum refrigerant tubing length of 165 ft. between indoor and outdoor units without the need for line size changes, traps or additional oil. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.
2. Cabinet: The casing shall be constructed from galvanized steel plate, coated with a finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a factory finish. The fan grille shall be of ABS plastic.
3. Fan: The fan motor shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across if from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.
4. Coil: The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be control by a microprocessor controlled step motor.

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5. Compressor: The compressor shall be a scroll compressor with variable speed inverter technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain enough heat. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.
  6. Electrical: The electrical power of the unit shall be as indicated on the drawings. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have Pulse Amplitude Modulation circuit to utilize 98 percent of input power supply.
  7. Provide BMS interface for system status monitoring.
  8. Manufacturer: Subject to compliance with requirements provide DCU AC Units of one of the following:
    - a. Mitsubishi
    - b. LG
    - c. Daikin
    - d. Or Equal
- 2.26 CONDENSATE DISCHARGE PUMPS (Refer to various equipment schedules for locations and SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)
- A. General: Provide where indicated, condensate pumps of capacity as scheduled, to be field installed in various air handling equipment drain pans, consisting of ABS housing, pump, check valve, safety switch, and thermal overload protection. Factory assembled unit must be UL/CSA listed.
  - B. High-Capacity Pumps
    1. Reservoir: Construct of ABS plastic with a 3/10 capacity volume.
    2. Pump: 25 GPH at 15TDH vertical type pump with stainless steel motor shaft, rustproof, ABS volute, with safety switch.
    3. Housing and Cover: Each shall be ABS plastic.
    4. Manufacturers: Subject to compliance with requirements, provide high-capacity condensate pump of Little Giant or approved equal:
  - C. Low-Capacity Pumps
    1. Pump: 8 GPH at 33TDH reciprocating piston pump direct discharge with no storage reservoir.
    2. Detection Unit: Low-maintenance filter free with a three level float (on/off/alarm).
    3. Pump Housing and Detection Unit: Each shall be ABS plastic.
    4. Manufacturers: Subject to compliance with requirements, provide low-capacity condensate pump of Sauermann or approved equal.

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## 2.27 FIRESTOP SYSTEMS

- A. General: Provide firestopping at all fire-rated construction where penetrated by the Work of this Section. Also, provide smoke sealing at all smoke barrier and smoke partition construction where penetrated by the work of this section.
- B. Refer to Section 078100 – APPLIED FIRESTOPPING and Section 078400 - FIRESTOPPING, for all product requirements for maintaining integrity of fire-rated and smoke rated construction at penetrations.

## 2.28 WALL AND CEILING ACCESS DOORS

- A. General: Furnish and install access panels, at all new construction where required for access to the Work of this Section. Furnish access doors for access to all concealed control valves, motor operated dampers, fire doors, and all other concealed parts of the HVAC system that require accessibility for the proper operation and maintenance of the system.
- B. Refer to Section 083100 - Access Doors and Frames, for all product requirements for furnishing access panels.
- C. Coordinate locations and schedule with the work of trades involved with construction in which access panels will be installed.
- D. Access doors shall be heavy gage steel with 1 in. frame. Door shall be fastened to frame with continuous piano hinge. Entire door and frame assembly shall be prime painted and be completed with cylinder lock and two keys. Door and frame shall match fire rating of wall or ceiling installed into.
- E. Manufacturer: Subject to compliance with requirements, provide access doors of one of the following:
  - 1. Inland Steel Products Company, "Milcor"
  - 2. Walsh-Hannon-Gladwin Inc., "Way Loctor"
  - 3. Or Equal.

## 2.29 WATER TREATMENT SYSTEMS

- A. RELATED DOCUMENTS: All M-Series, E-Series and P-Series Drawings and related specifications.
- B. SUMMARY
  - 1. The Water Treatment is to include both construction services of hydrotesting, precleaning, flushing and passivation. Also, one year of service after the construction is completed. For all systems in the facility.
  - 2. The Water treatment maintenance services shall be comprehensive in nature. The intent of the water treatment services shall be to:
    - a. Maintain clean water systems, free of harmful growths or bacteria, especially pathogens and other bacteria that can inhibit proper heat transfer, cause disease or enhance corrosion.
    - b. Prevent excessive corrosion of piping and all equipment.
    - c. Maintain pH, dissolved solids, and particulate at optimum levels.



- d. Prevent deposit or scale buildup on heat transfer surfaces.
3. The Water Treatment Service Company shall provide all testing, chemicals, control equipment, chemical feed pumps, monitoring equipment (where required), service/labor, and expertise to meet these objectives.
4. The systems to receive water treatment service are as detailed below, each system with the exception of the condenser loop is provided with 35% by weight propylene glycol.
  - a. Chilled Water
    - 1) Chilled Loop - Estimated Size 4,500 gallons with one absorption chiller.
  - b. Heating Hot Water
    - 1) Heating Hot Water Loop - Estimated Size 4,000 gallons with one hot water heat exchanger and boilers.
  - c. Open Recirculating - Cooling Water – Condenser Loop
    - 1) There is one open recirculating cooling water condenser loop system at 600 gallons. (1 cooling tower).
    - 2) The System - consists of 1 cooling tower (100 Tons) that supply condenser water to one absorption chiller unit. For this bid, estimated operation is 100 tons at dual temperature hours per year, 75% load.
  - d. Dual Temperature System
    - 1) Dual Temperature System - Estimated Size 3,000 gallons
5. This section includes the following water treatment and equipment for this project:
  - a. Manual and automatic chemical feed equipment.
  - b. Hydrotesting chemicals
  - c. Cleaning chemicals
  - d. Passivation chemicals
  - e. Chemical treatment test equipment.
  - f. Cooling Tower Water Inhibitors
  - g. Cooling Tower Water Biocides
  - h. Chilled Water Corrosion and Biocide Treatments
  - i. Heating Hot Water Corrosion and Biocide Treatments
  - j. Services to be provided.
6. The Water treatment program will cover an additional one year period after the substantial completion of the construction period.

C. QUALIFICATIONS OF WATER TREATMENT SERVICE PROVIDER

1. The Water Treatment Service Provider must provide water treatment programs to actively serve a clientele in the Framingham, MA area. They shall be familiar with, experienced in, and regularly engage in the design, manufacture, application, and service of cooling water – open recirculating water systems, closed water systems (both hot and chilled water) and dual temperature and Cogen hot water systems. They shall demonstrate experience in areas that include training, testing, and troubleshooting such systems.
2. The Water Treatment Service Provider shall provide documentation and references of having a minimum of five (5) years' experience with water treatment programs similar to that offered under this specification and using similar chemical treatment products. Include in shop drawing submission.
3. The Water Treatment Service Provider must have at least five (5) active treatment programs using chemicals and services similar to those offered under this proposal and functioning with a makeup water chemistry similar to that available to the Framingham, MA Documentation and references, including names and telephone numbers must be included in shop drawing submission.
4. The Water Treatment Service Provider must have a technical sales/service facility within 200 miles of Framingham, MA and be capable of responding personally to the site within 24 hours of notification. This facility shall include individuals who can not only fulfill various ordering and delivery requirements but who can also troubleshoot water and equipment problems and provide technical solutions. The individual assigned to service the program herein proposed must have documentable experience of at least five (5) years in similar water treatment service work plus evidence of at least five (5) years tenure in the same geographical area and with the same client accounts. **An individual with a Certified Water Technologist certification or equivalent experience is required.** This individual must also be supported by a staff of senior engineering experts and a well-equipped corporate laboratory capable of performing special analyses on corrosion coupons, deposits, microbiological samples, and other critical water treatment parameters. Documentation to be issued during the submittal process for review and approval.

D. DEFINITIONS

1. Certified Water Technologist (CWT) – The CWT is a certification that shows the holder to have the expertise, experience, and knowledge to provide the highest standards of service for providing and monitoring a water treatment program. They pride themselves on making facilities as efficient as possible using the latest water treatment technology and techniques to save energy and prevent scale, corrosion, fouling, deposition and microbiological growth.
2. Individuals with the CWT designation have personally committed themselves to excellence in the water treatment industry. Each CWT has passed a rigorous exam that covers all aspects of water treatment technology, and they must recertify every five years to maintain the credential. The CWT designation is administered by the Association of Water Technologies.

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E. PERFORMANCE REQUIREMENTS

1. Water quality for HVAC systems shall minimize corrosion, scale build-up, general particulate fouling and biological growth to allow for optimum efficiency of the HVAC equipment without creating a hazard to operating personnel or the environment. The systems will be chemically treated to prevent such occurrences. No chromates or other regulatory (State, Local or Municipal) forbidden chemicals shall be utilized.
2. Hydrotesting, cleaning, flushing, passivation of all of the systems in this project are to be done by the Mechanical Contractor with oversight from the Water Treatment Service Provider. The Water Treatment Service Provider is responsible for determining the compatibility of the chemicals that will be utilized with all of the metallurgies involved.
3. The HVAC water treatment should be based on the quality of water available at the project site, HVAC system equipment material characteristics, metallurgies involved and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction. A report documenting that the Water Treatment Service Provider analyzed the incoming project site water, and describing its characteristics, shall be supplied to the Construction Manager, Project Engineer and the Facility Maintenance Department. The testing must include: date sample was taken, date sample was analyzed for P&M alkalinity, calcium, magnesium, total hardness, pH, conductivity, chlorides, sodium, sulfate, zinc, potassium, silica, iron, copper, barium, aluminum, manganese, strontium, ortho-phosphate, poly-Phosphate and nitrates.
4. The systems shall not be hydrotested without a chemical additive being added to the make-up water. The chemical additive shall include a Vapor Phase corrosion additive to prevent flash rusting when the system is drained. The hydrotesting must be overseen by the water treatment service provider in order to prevent excessive corrosion.
5. The pre-cleaning and flushing of the systems must be done with the oversight of the Water Treatment Service Provider. It must also be documented in a formal report supplied to the construction manager and project engineer, including the steps taken during pre-cleaning and flushing. Water analyses must be done as listed in Section E.7 on every system that is to be precleaned and flushed during every phase done during each of the steps and a final flushing water quality analysis with particle size distribution analyses conducted on the final flush water.
6. The passivation of the systems must be done with the oversight of the Water Treatment Service Provider. It must also be documented in a formal report supplied to the general contractor and project engineer, including the steps taken during the passivation, especially if a galvanized or aluminum metallurgy is utilized. Passivation of these metallurgies is extremely important and under no circumstances should damage to these metallurgies be allowed. If there is an issue with timing and passivation, the water treatment service provider will provide documentation to the Construction Manager, Project Engineer and the Manager of Facilities. discussing the facts and the issues before he continues. Water analyses, as listed in Section E.7, must be done on every system and must be done during every phase done during each of the steps of passivation. For the cooling tower, pictures need to be taken during each of the steps to verify conformance.

7. A formal report should also document the quality of the treated systems. The quality of the treated water must meet the specifications, if there are any, set forth by the HVAC equipment manufacturers. If no such specifications exist for the equipment, a full analysis must be done (See Section E.7). This analysis must also include inhibitor levels and particle size distribution analysis, that documents the quality of the water/fluid. If glycol is required in the project, the full analysis must include organic acidity, glycol degradation products, corrosion inhibitors, scale promoters, contaminants, corrosion by-products and general qualities of the glycol including concentration, type and freeze point.
8. Water Testing that must be done on all samples for the precleaning, flushing and passivation stages:

P & M Alaklinity (as CaCO <sub>3</sub> )	Zinc (as Zn)
Chlorides (as NaCl)	Silica (as Si)
Calcium (as Ca)	Aluminum (as Al)
Magnesium (as Mg)	Total Iron (as Fe)
Total Hardness (as CaCO <sub>3</sub> )	Dissolved Iron (as Fe)
pH	Total Copper (as Cu)
Conductivity	Dissolved Copper (as Cu)
Sodium (as Na)	Manganese (as Mn)
Potassium (as K)	Ortho – Phosphate
Sulfate (as SO <sub>4</sub> )	Poly - Phosphate
Oil and Grease	MBAS (Surfactants)
Total Organic Carbon	Suspended Solids

The stages that analyses are required are:

- Before Cleaner is added
  - After Cleaning
  - After Flushing ( must include Particle Size Distribution Analysis)
  - After Passivation ( must include Particle Size Distribution and Inhibitor Levels)
9. The water chemistry and quality of the chemical treatment program during the one year period after the initial construction phase will influence the corrosion rates of the system. These shall be measured by corrosion coupons using un-passivated coupons and following the ASTM procedures for monitoring corrosion rates. The Water Treatment Service Provider shall supply standard ASTM D2688 Method B corrosion coupons in carbon steel (C1010), copper (CDA110), Galvanized Steel and other metallurgies in the systems for

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installation in coupon holders to be placed in the systems. The Service Provider will conduct the testing by installing the coupons in the coupon holders and supplying all coupon racks. (Note: Coupons are not to be pre-passivated). These coupons will be reweighed by the supplier company and examined by them after exposure for weight loss, deposit accumulation, deposit analysis (where appropriate) and general appearance. A written report with photographs (before and after cleaning) of the results of this examination will be submitted to the Construction Manager, Project Engineer and the Facilities Manager of the Middle School within two weeks of coupon removal. Coupons will be installed in various systems to establish a historical data base. Priority will be given to systems where there is a suspicion or evidence of a corrosion problem but in no case in less than the following systems:

- Four sets per year in all chilled and hot water systems.

These surveys shall be run at between 30 days to 90 days following initiation of the treatment program. In no case shall coupons be exposed for longer than a 90-day period. The treatment program shall be designed to maintain for the corrosion rates as listed in the table below:

System Type	Carbon Steel (C1010)	Copper (CDA110)
Chilled Closed Loop	Less than or equal to 0.2 mpy	Less than or equal to 0.1 mpy
Hot Water Closed Loop	Less than or equal to 0.2 mpy	Less than or equal to 0.1 mpy

**Note: These rates assume that the metal loss is uniform with no pitting or localized attack including gouging, etching, microbial attack or crevice attack. Conditions such as those are not acceptable. If they are noted, the cause should be addressed with follow-up testing to confirm improvement. Localized attack at the coupon holder may be ignored if the treatment is unable to interact with the coupon in this area and no other abnormalities are noted.**

10. The water chemistry and quality of the chemical treatment program during the two year period after the initial construction phase will influence how the system operates. The Water Treatment Service Provider will perform monthly water analyses based on the tables below. From these analyses the Water Treatment Service Provider will properly assess the performance of the complete water treatment program. A monthly formal report will be issued to the Construction Manager, the Project Engineer and the Manager of Facilities.

<b>Table of Monthly Testing Required</b>		
Tests	Chilled Water & Hot Water	City Water
P Alkalinity		X
M Alkalinity		X
Chloride	X	X
Calcium Hardness		X
Total Hardness	X	X
pH	X	X
Dissolved Iron	X	X
Conductivity	X	X
Silica		X
Dissolved Copper	X	
Ortho-Phosphate		X
Poly-Phosphate		
Phosphonate		
Zinc		
Inhibitor Concentration including azole	X	
Total Bacteria – Plate Count	X	
Total Fungal Count	X	
Total Slime Formers	X	
Sulfate Reducing Bacteria	X	
Iron Reducing Bacteria	X	
Denitrifying Bacteria	X	

11. The water chemistry and quality of the chemical treatment program during the two year period after the initial construction phase will influence the heterotrophic biological growth in these systems. Microbiological population/growth analyses shall be conducted on chilled bulk waters on a monthly basis, using dip stick methods, petri-film or ATP or by the corporate support laboratory, using incubated culture methods. A minimum of one such sample per month will be run for each operating cooling tower with additional tests as required where it is suspected that problems or upset conditions exist. All results shall be submitted in writing within fifteen (15) days of the test. For field testing and immediate results, dip stick, petri-film and ATP analysis will all be acceptable but these results must be supported by a detailed analysis in the corporate support laboratory. Each test must be run on a sample drawn from the same location, under the same operating conditions, and at the same time following biocide application. Total microbiological population shall be maintained at 1,000 organisms per milliliter or less. Total fungal populations shall be maintained at non- detectable. SRB and IRB, along with other corrosion causing bacteria shall also be maintained at non-detectable levels. A formal report issued to the Construction Manager and the Project Engineer should provide evidence of this upon every service visit. If bacteria is above these levels in these systems the Water Treatment provider will provide extra biocide to control these bacteria at no extra cost.
12. Microbiological population/growth analyses shall also be conducted on screen coupons placed in corrosion coupon racks to monitor slime or sessile bacterial growth in the chilled bulk waters on a monthly basis, using dip stick methods, or by the corporate support laboratory, using incubated culture methods. A minimum of one such sample per month will be run for each operating cooling tower with additional tests as required where it is suspected that problems or upset conditions exist. All results shall be submitted in writing within fifteen (15) days of the test. Total microbiological population shall be maintained at 1,000 organisms per milliliter or less. Total fungal populations shall be maintained at non-detectable. SRB and other corrosion causing bacteria shall also be maintained at non-detectable levels. A formal report issued to the Construction Manager and the Project Engineer should provide evidence of this upon every service visit. If bacteria is above these levels in these systems the Water Treatment provider will provide extra biocide to control these bacteria at no extra cost.
13. The Water Treatment Provider will also provide and change all bag filters in the closed loop filter/feeders that are installed on the closed loops.
14. The Water Treatment Provider must agree to haul away all used chemical drums, boxes or bags to an acceptable licensed disposal site at no additional cost to the City of Framingham or Middle School.
15. Chemical Containment - all chemicals on-site need to be stored in chemical containment so any leaks in the container gets captured and not distributed onto the floor or other areas at the Fuller Middle School site. All containment must be 150% of the chemical capacity of the drums or containers stored on them.

16. The Water Treatment Provider shall maintain an inventory of treatment chemicals at the facility, sufficient to ensure that the supply will not be exhausted before replenishment but not to exceed a 90-day supply beyond those containers presently in use. A 40 day inventory of materials must be maintained on site so that chemical treatments are always maintained in each system. Just in time inventory is not acceptable.
17. For each proposed water treatment chemical, Water Treatment Provider shall propose a dosage rate with test control ranges for the trace parameter. Using these dosages and the operating data for the system, The Provider shall provide a documented calculation of the estimated consumption of each chemical, on the basis of yearly consumption or consumption per 1,000 gallons of system capacity or makeup rate, as appropriate. Provider shall indicate cycles of concentration in calculating consumption of all water treatment chemicals. **This all must be included with the Submittal and Contractor's bid.**
18. Disposal of Used Containers – Water Treatment Provider must agree to haul away all used chemical drums, boxes or bags to an acceptable licensed disposal site at no additional cost to the City of Framingham or Middle School.
19. All water treatment chemicals shall be packaged in sturdy, DOT-approved drums, carboys, or bags, palletized and delivered to the specified receiving dock. All chemicals will be distributed to the different areas by the Water Treatment Provider. The Fuller Middle School personnel will not move chemicals or remove empty drums from the site. This is all the responsibility of the **Water Treatment Provider. Note: The Fuller Middle School would prefer a drumless operation or mini-bulk delivery program.**

F. SUBMITTALS

1. Documentation of Experience as listed in Section C
2. Documentation of CWT Certification as listed in Section C
3. List of other accounts served in the Framingham Area
4. Chemical test equipment Product Data Bulletins
5. All chemicals that will be utilized (Hydrotesting, Pre-cleaning, Passivation) – SDS's and Product Data Bulletins which must include feed rates for this project.
6. Chemical bypass feeders - Product Data Bulletins
7. All Chemical Feed Equipment - Product Data Bulletins
8. Glycol feed units - Product Data Bulletins
9. All chemicals that will be utilized for operational treatment – SDS's and Product Data Bulletins which must include feed rates for this project.
10. Calculations for use amount including all projected water use rates and chemical usage.
11. Wiring Diagrams for all control equipment - Detail power and control wiring and differentiate between manufacturer - installed and field installed wiring.
12. Flow Diagrams for all control equipment and valve package installation of equipment especially those that differentiate between manufacturer - installed and field installed.



13. Water Treatment Protocols: Written sequence of protocols to be established for hydrotesting, pre-cleaning and flushing of the piping and equipment.
14. Water Treatment Protocols: Written sequence of protocols to be established for normal operational parameters, also for shutdown and start-up.
15. Water Analysis and Formal Reports: See Section E – Examples of these documents must be supplied with the bid.
16. Operation and Maintenance Data: For sensors, injection pumps, filters, system controls, and accessories to include in emergency, operation, and maintenance manuals specified for this project.

G. QUALITY ASSURANCE

1. HVAC Water Treatment Service Provider Qualifications: An experienced HVAC Water Treatment Service Provider with a “CWT” designation as offered by the Association of Water Technologies shall be required for this project. The Water Treatment Service Provider must be capable of analyzing water qualities, installing water treatment equipment, and applying water treatment as specified in this Section.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

H. MAINTENANCE SERVICE

1. Scope of Maintenance Service: Provide services as described above and then for two years after the construction project per Section E. services.
2. The Contractors service representative shall visit the complex at least once every month. The dates of the service calls will be prearranged at the convenience of the Fuller Middle School personnel. During each of these visits, the representative will take and analyze samples as indicated within this specification, will visit with operators and supervisors in the complex as indicated to answer any questions and probe for incipient problems, and will examine performance check information for the monitors indicated within this specification. Results of field analyses plus a narrative report of observations, conclusions and recommendations will be submitted by a written report or computer generated report no later than on the next day from the date of service, with any follow-up reports discussing major issues observed at the time of the service visit being issued within one week of the service visit.
3. The technical service representative shall be available by phone within an 8-hour period and should be able to be on-site or have some technical representative on-site within 24 hours of a phone call.
4. The technical service representative shall also coordinate with the Fuller Middle School personnel the dates of chiller equipment, heat exchanger, cooling tower openings for inspection and/or troubleshooting services. Results of any such inspections shall be documented by written reports, deposit analyses and photographs, if appropriate.

5. At least two times a year, the Contractors' technical service representative shall meet with Fuller Middle School Facility Director and the Engineer of Record to review the progress of the program during the previous six months and to discuss plans for any changes or improvements in the next six months. At least one of these meetings each year should include the participation of a senior technical expert from the Contractor's corporate engineering staff.
6. The contractor may also be called on to work with the City of Framingham Consulting Engineer who could request to review all of the contractor's information.
7. At least once every six months during a service visit, the Water Treatment Service Providers' representative shall take a sample of city water makeup, from each of the chilled water, hot water heating system. Two identical samples will be taken in bottles provided by the Contractor. The second sample will be tested on the spot by the service representative but, more importantly, the first sample shall be transmitted to the Contractors' corporate laboratory for analysis. This analysis will include all the parameters the field representative has tested for and also those not able to be determined with field test kits or analyses, requiring more sensitive and precise methods, available only in the central laboratory (ex: total iron, total copper, azole concentration, polymer concentration and poly-phosphate, aluminum and barium on the city water.) The Contractors' laboratory shall report results of their analysis within one month of sample submission with interpretive comments including Langelier Index, comparison with Service Representative results and cycles of concentration based on chloride or silica. These results will be reported in writing to the Fuller Middle School personnel.
8. Occasionally the Contractors' service representative should provide special supplemental services to evaluate the condition of equipment involved with the water treatment program. Such services should include, but not be limited to, fiberoptic scoping of heat exchangers and computer analysis of chiller efficiencies. These should be provided at no additional charge to the City of Framingham or Middle School.
9. Training
  - a. The Contractors service representative shall instruct, on an ongoing basis, all Fuller Middle School operators in all the activities of a water tester, specifically in taking samples, running applicable control tests, interpreting test results, feeding chemicals, changing chemical feed rates, and modifications of treatment control equipment (pumps, timers, blowdown valves, interlocks, instrumentation, etc.). The instruction should also cover the purpose of each treatment chemical, its recommended control range, and actions to take should the test results be out of range, as well as the consequences of allowing the treatment to remain out of range.
  - b. A training program like this also must be done at least once per year and should include any new operators or employees dealing with the water treatment program.

- c. The Water Treatment Provider shall provide instruction / operation manuals in sufficient number to provide one copy for each operator, supervisor and the City of Framingham Engineer. These manuals shall include full descriptive information on chemical products being used, product bulletins and safety data sheets for each, procedures for all recommended water tests, control limits for the tests, and purpose of each chemical treatment. Water testing procedures and control limits should be posted separately near each water testing location.

10. Reports

In agreement with previous sections of this specification, the following reports shall be supplied by the Water Treatment Provider to a Chain of Command agreed upon by the Fuller Middle School or City of Framingham.

- a. A handwritten or computer report summarizing results of the service representative's monthly visits, including results of any field tests on water samples compared with recommended control ranges, usage rates of treatment chemicals, inventory control data, and a narrative interpretation of treatment control, troubleshooting observations, and suggestions for needed changes in treatment. This report shall be left at the conclusion of each service visit.
- b. Computer generated reports of the results of any performance checks such as corrosion coupons, deposit analyses, or any other analyses.
- c. Computer generated reports of the results of corroborative/supplementary water analyses conducted by the Contractors' corporate laboratory.
- d. Follow-up computer generated reports on all problems noted during the service visit, what caused them, and recommendations for correction.
- e. Computer generated summaries of the semiannual progress meetings stating the work accomplished during the past six-month period and work to be accomplished during the subsequent six-month period plus any problems needing attention by the Contractor or Fuller Middle School.
- f. Full engineering reports giving the results of any equipment inspection, documented by deposit analyses and photographs, if appropriate.

(NOTE: All reports will be sent to a list of individuals as specified by the City of Framingham to **verify that all pertinent personnel are aware of what is occurring with the water systems and to verify that communications were received.**)

I. MANUAL AND AUTOMATIC CHEMICAL FEED EQUIPMENT

1. Closed Loops (Hot and Chilled Water)

a. Bypass Filter Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch (89-mm) fill opening in the top, and NPS 3/4 (DN 20) bottom inlet and top side outlet. Feeder shall have a stainless steel dissolving basket that fully supports the filter bag. The filter bag shall be the 5-micron type with ring top and handle. The feeder shall have only a threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel. The filter feeder shall be similar to Neptune Model FTF-5DB.

1) Capacity: 5 gal. (19 L).

2) Working Pressure: 125 psig (860 kPa)

b. Four Station Corrosion Coupon Test Rack and Assembly: Constructed of corrosion resistant material, complete with piping, valves, strainer, flow monitoring device, quick disconnect O-ring sealed coupon holders, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test coupon assembly. One corrosion coupon rack is necessary for each system in this specification.

J. CHEMICALS

1. Chemicals shall be furnished and installed as recommended by the Water Treatment Service Provider and the equipment manufacturer. The Water Treatment Service Provider will determine if the chemicals are compatible with piping system components and connected equipment and that they can attain water quality specified in within the SpecificationsD.

2. Hydrotest Inhibitor: All hydrotest water shall contain a corrosion inhibitor package and biocide to protect the system from corrosion and biological growth during stagnant periods or draining. This inhibitor package must be added during all hydrotesting. The corrosion inhibitor must also include a vapor phase corrosion inhibitor in case all of the system is not full. NOTE: VERIFY THAT HYDROTESTING INHIBITOR PACKAGE IS COMPATIBLE WITH THE EQUIPMENT ON THE SYSTEM. THIS MUST BE DONE BY THE WATER TREATMENT SERVICE PROVIDER.

3. System Cleaner: As recommended by the Water Treatment Service Provider and system manufacturer to remove grease and petroleum products, flash rusting agents and other particulate in the system. NOTE: VERIFY THAT SYSTEM CLEANER IS COMPATIBLE WITH THE EQUIPMENT ON THE SYSTEM (Especially if Aluminum or Galvanized are Utilized.) THIS MUST BE DONE BY THE WATER TREATMENT SERVICE PROVIDER.

4. Closed Loop Water Piping Treatment Chemicals: As recommended by the Water Treatment Service Provider and system manufacturer to reduce deposits, inhibit corrosion and control biological growth. It also must comply with the system water quality performance requirements specified in Section E. This product is for use during the normal operation of the system. NOTE: VERIFY THAT SYSTEM CORROSION INHIBITORS AND BIOCIDES ARE COMPATIBLE WITH THE EQUIPMENT ON THE SYSTEM. THIS MUST BE DONE BY THE WATER TREATMENT SERVICE PROVIDER.

5. Closed Loop Water Piping Passivation Chemicals: As recommended by the Water Treatment Service Provider and system manufacturer to reduce deposits, inhibit corrosion and control biological growth. It also must comply with the system water quality performance requirements specified in Section E. This product is for use during the time between flushing and glycol addition to keep the system from corroding and to keep bacteria from growing. NOTE: VERIFY THAT SYSTEM CORROSION INHIBITORS AND BIOCIDES ARE COMPATIBLE WITH THE EQUIPMENT ON THE SYSTEM. THIS MUST BE DONE BY THE WATER TREATMENT PROVIDER.

K. CHEMICAL TEST EQUIPMENT

1. The supplier will provide, at minimum, a conductivity meter, glycol refractometer (if glycol is used), inhibitor verification test chemical reagents and equipment to verify that the various systems are in conformance with operational parameters. The Water Treatment Service Provider will select all of the testing required for this project for the facility operational staff to conduct in order to verify conformance.

L. TRAINING AND DEMONSTRATION

1. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC water treatment systems and equipment. See Section H for all that must be included.

2.30 AUTOMATIC TEMPERATURE CONTROLS (Refer to SECTION 019113 and 230800 COMMISSIONING for additional contract requirements)

A. Basic Components and Systems:

1. General: Provide control products in sizes and capacities indicated, consisting of dampers, thermostats, clocks, sensors, controllers, and other components as required for completed installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information, designed and constructed as recommended by manufacturer and as required for application indicated. All equipment and systems shall be installed by factory trained contractors with the following functional and construction features.
2. The building automation system shall be based on the latest version (Version 4) of Tridium Niagara platform and shall be on an open protocol BACnet system infrastructure that integrates diverse systems and devices (regardless of manufacturer, communication standard ie BACnet, Lon, Modbus or software) into a unified platform that can be read and written to and easily managed in real time using a standard Web browser. Systems not developed on a Tridium Niagara platform with BACnet protocol are unacceptable. The building automation system shall not require licensing fees and shall be licensed indefinitely to the Owner for use at the project site with all required programming software tools.
3. ATC manufacturer shall provide written confirmation that installing ATC Contractor is an authorized dealer and service provider. The ATC system provided must be capable of being serviced by three or more local authorized vendors/contractors.

4. Provide all required control wiring including CAT6 Ethernet wiring for all controllers requiring Ethernet connectivity BACNet-IP connections, BACNet MSTP is prohibited on any ATC Controller including field and terminal controllers. Terminate Ethernet cable in MDF and IDF closets on patch panels proceed under Technology Section 270000.
5. Install an open-protocol (BACnet) energy management system (EMS) to monitor and trend the energy consumed by the following systems throughout the school:
  - a. HVAC systems
  - b. Hot and cold domestic water systems
  - c. Electric service meters
  - d. Gas meters
6. The ATC control and building EMS system shall have the following attributes with characteristics and performance as specified within this Specification section, related Electrical and Plumbing section specifications and the Control Diagram drawings:
  - a. Sensors as follows:
    - 1) Sensors to trend outdoor air temperature
    - 2) Indication and trending of damper and valve commanded positions.
    - 3) Sensors to monitor building electrical and natural gas consumption. Electrical meters shall be provided by the Electrical Contractor and control wiring from the meters to the EMS system shall be provided by the ATC contractor. Gas meters shall be furnished and installed by the Plumbing contractor. The ATC contractor shall provide control wiring from the meters to the BMS. Flow meters for building cold water consumption will be installed by the Plumbing Contractor and furnished and wired to the BMS by the ATC Contractor. Domestic hot water shall be relays on each domestic water heater burner and through BMS programming utilizing burner on/off operation domestic hot water consumption will be determined, all provided by the ATC Contractor.
    - 4) Sensors to monitor indoor and outdoor CO2.
    - 5) Sensors to monitor and trend (create trend logs) controlled variables at the operator interface. Control variables may include air and/or water flow, temperature, pressure, CO2, and pump or fan speed. Relevant multiplexed data from microprocessors located in chillers, boilers, variable speed drives and other equipment with multiplexing capabilities may be used in lieu of specifying separate sensors.
    - 6) All densely occupied spaces, with occupant density of 25 people or more per 1000 s.f. must be provided with CO2 sensors per LEED IEQC1 requirements. Provide multi functioning sensors with temperature, humidity and CO2 for all spaces except for storage rooms and toilet rooms.
  - b. Points matrix – including all hardwired input and output devices connected to the automation system, all set points, upper and lower control limits.

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- c. Trend capabilities – including a trend point list and preprogrammed sample of point (performed by controls contractor), sample rate, storage interval, upload interval, custom trend abilities, alarms, and automated trend data review and notification (automated diagnostics).
  - d. System architecture – capable of allowing sampling of these points to facilitate building commissioning and diagnostics without significantly affecting system performance.
  - e. Data storage system – with adequate capacity to record trend data for use by building operators. Data export requirements must facilitate user-friendly data access and manipulation.
  - f. Operator interface – designed for remote/web access, monitoring requirements, trend-log reporting and diagnosing building problems through a user-friendly interface. This includes providing a visual (non text based) operations and reporting interface to facilitate rapid system assessment that utilizes color-coding, diagrams of floor plans and graphing capabilities.
  - g. The remote access shall use a web browser only and not require a VPN with remote desktop application.
7. Electric Wiring: All electric wiring and wiring connections, either line voltage or low voltage, from the emergency electric panels to the ATC panels, and from the ATC related panels to the individual control devices i.e. rooftop units, exhaust fans, boilers, chillers, valves, and dampers required for the installation of the control system, as herein specified shall be provided by the control contractor unless specifically shown on the electrical drawings or called for in the electrical specifications.
- a. The wiring installation shall be in accordance with National and Local Codes and with the Electrical portion of these specifications. All wiring shall be run concealed wherever possible. Exposed wiring in occupied areas shall be run in raceways. Raceways shall be Wiremold 200 series with all elbows, raceways, covers, mounting stops, box extensions and wiring for a complete and neat installation. All wiring located in mechanical spaces, boiler rooms, and fan rooms shall be installed in metal conduit
  - b. All wiring above ceilings, in boiler rooms, and all mechanical spaces shall follow routing of piping and where not possible shall be in conduit. All exposed wire shall be bundled and wire tied and shall be supported to adjacent piping. Draped and free floating wire will not be allowed.
  - c. All terminations of wire at control devices shall be looped and supported adequately.
  - d. All wiring shall comply with the requirements of the electrical section of the specification.
- B. Controls Systems Wiring
1. All conduit raceways, wiring, accessories and wiring connections required for the installation of the Controls Systems shall be provided by the Controls Contractor except as shown on the Electrical Drawings. All wiring shall comply with the requirements of applicable portions of the Electrical Section 260010 and all local and national electric codes and the requirements of the AHJ.

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2. All Controls Systems wiring materials and installation methods shall comply with the original equipment manufacturer recommendations and standards.
  3. The sizing type and provision of cable, conduit, cable trays and raceways shall be the design responsibility of the Controls Contractor.
  4. Class 2 Wiring
    - a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
    - b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5ft. from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines.
  5. Class 2 signal wiring and 24VAC power may be run in the same conduit. Power wiring 120VAC and greater shall not share the same conduit with Class 2 signal wiring.
  6. Perform circuit tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that:
    - a. All circuits are continuous and free from short circuits and grounds.
    - b. All circuits are free from unspecified grounds; that resistance to ground of all circuits is no less than 50 megohms.
    - c. All circuits are free from induced voltages.
  7. Provide complete testing for all cables and wiring. Provide all equipment, tools, and personnel as necessary to conduct these tests.
  8. Provide for complete grounding of all signal and communication cables, panels and equipment so as to ensure integrity of Controls Systems operation. Ground cabling and conduit at panel terminations. Do not create ground loops.
- C. Line Voltage Power Sources
1. 120-volt AC circuits for the Controls Systems shall be taken by the Controls Contractor from electrical emergency panelboards and circuit breakers as designated on the electrical drawings.
  2. Circuits used for the Controls Systems shall be dedicated to these Controls Systems and shall not be used for any other services.
  3. Controls DDC terminal unit controllers may use 120-volt AC power from motor power circuits.
- D. Controls Systems Raceways
1. All wiring shall be installed in conduit or raceway except as noted elsewhere in the Specification. Minimum conduit size 3/4 in.
  2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
  3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the supporting surface.



4. UL/ULC Listed Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 ft. in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls and for final connection to equipment.

E. Penetrations

1. Firestopping for all penetrations used by dedicated Controls Systems conduits and raceways shall be by other trades.
2. All openings in fire proofed or fire stopped components shall be closed by other trades using approved fire resistive sealant.
3. All wiring passing through penetrations, including walls, shall be in sleeves, conduit or enclosed raceway.
4. No penetrations through building structural elements, slabs, ceilings and walls shall be made before receipt of written approval from the Architect.

F. Controls Systems Identification Standards

1. Node Identification: All nodes shall be identified by a permanent label fastened to the outside of the enclosure. Labels shall be suitable for the node environmental location.
2. Cable shall be labeled at every termination with cross-referencing to record documentation.
3. Raceway Identification: Exposed covers to junction and pull boxes of the FMS raceways shall be identified at primary points.
4. Wire Identification: All low and line voltage wiring shall be identified by a number, as referenced to the associated shop and record drawing, at each termination.
5. Wires and cabling shall not be spliced between terminations. Cable shields shall be single end grounded – typically at the panel end outside the panel.
6. Suggested color coding, for use at the Contractors option, are:
  - a. Analog Input Cable           Yellow
  - b. Analog Output Cable        Tan
  - c. Binary Input Cable           Orange
  - d. Binary Output Cable         Violet
  - e. 24 VAC Cable                 Gray
  - f. General Purpose Cable       Natural
  - g. Tier 1 Comm Cable           Purple
  - h. Other Tier Comm Cable       Blue
  - i. Ethernet cable                Blue
7. Provide permanent identification labels at all valve and damper actuators to indicate open and closed positions.

- G. Field Panel And Device Installations And Locations
1. The Controls Systems panels, enclosures and cabinets shall be located as coordinated with the Architect at an elevation of not less than 2 ft. from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
  2. All field devices shall be installed per the manufacturer recommendation and in accessible locations as coordinated with the Architect.
  3. Panels to be located in damp areas or areas subject to condensation shall be mounted with wall standoffs.
  4. Conduit configurations entering or leaving panels and devices shall be such as to preclude condensation traps.
- H. Networking Communications
1. The design of the BAS shall network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of multiple levels for communication efficiency, a campus-wide (Management Level Network) Ethernet network based on TCP/IP protocol, high performance peer-to-peer building level network(s) and DDC Controller floor level local area networks with access being totally transparent to the user when accessing data or developing control programs.
  2. System shall communicate with a BACnet network over Ethernet using BACnet/IP (according to Annex J). The intent is to use the system provided under this contract to communicate with control systems and/or devices provided by other vendors. A BAS system submittal including diagrams indicating all PICS, NIC, Controllers, and Wiring shall be provided describing the BACnet, ANSI/ASHRAE 135-95, implementation. The product shall be Network Application Engine level 1 controllers with field equipment controller for level 2 controllers no substitutions. Minimum system functionality must include monitoring, commanding, and alarming for daily operator functions from a common workstation.
    - a. System shall have the capability to be an OPC Client and Server for dynamic communication with OPC Clients or Servers over an Ethernet network. At a minimum, the following must be supported:
      - 1) Data Access 1.0 (96), 1.0A (97) and 2.0 (11/98)
      - 2) Alarms & Events 1.0 (1/99)
  3. Network Switches
    - a. Provide HP ProCurve 2910 al series 2910-48G al 48 ports network switch Brocade, Cisco or equal in MDF/IDF rooms as required.
  4. Ethernet Wiring
    - a. Ethernet wiring shall be CAT6 UTP cable plenum rated. CAT6 UTP cables shall conform to ANSI/TIA/EIA-568-B1, B2, B3 Commercial Building Telecommunications Cabling Standard (latest amendment and including all applicable addenda) and ISO/IEC 11801 (International) Generic Cabling for Customer Premises standard (latest amendment and including all applicable addenda).

5. Building Data Network:
  - a. All operator devices either network resident shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.
  - b. The network shall support a minimum of 100 DDC controllers and PC workstations
  - c. The system shall support integration of third party systems (fire alarm, security, lighting, PLC, chiller, boiler) via panel mounted open protocol processor. This processor shall exchange data between the two systems for interprocess control. All exchange points shall have full system functionality as specified herein for hardwired points.
  - d. Field panels must be capable of integration with open standards including Modbus, BACnet, and Lonworks as well as with third party devices via existing vendor protocols.
  - e. The Building Network shall use the TCP/IP over Ethernet. All devices must:
    - 1) Auto-sense 10/100/1000 Mbps networks.
    - 2) IP Address will be assigned by Owner's IT staff.
    - 3) DNS and Gateway IP address will be provided by Owner's IT staff. A VLAN will be setup by Owner's IT staff.
    - 4) Allow access using Telnet.
6. Internet access
  - a. Web Based Operator Interface
    - 1) The BAS shall provide a web based graphical interface that allows users to access the BAS data via the Internet. The interface shall use HTML based ASP pages to send and receive data from the BAS to a web browser.
    - 2) All information exchanged over Internet shall be encrypted and secure via SSL.
    - 3) Access to the web interface will be password protected. A users rights and privileges to points and graphics will be the same as those assigned at the BAS workstation. An option will exist to only allow users "read" access via the web browser, while maintaining "command" privileges via the BAS workstation.
    - 4) Commissioning of the Web interface shall not require modification or creation of HTML or ASP pages. All graphics available at the BAS graphical workstation shall be available to users via a web browser.
    - 5) The web-based interface shall provide the following functionality to users, based on their access and privilege rights:
      - a) Logon Screen – allows the user to enter their user name, password and Domain name for logging into the web server.

- b) Alarm Display – a display of current BAS alarms to which the user has access will be displayed. Users will be able to acknowledge and erase active alarms, and link to additional alarm information including alarm messages, and informational and memo text. Any alarm acknowledgements initiated through the web interface will be written to the BAS central workstation activity log.
  - c) Graphic Display – Display of system graphics, including animated motion, available in the BAS workstation will be available for viewing over the web browser. Software that requires creation of dedicated “web” graphics in order to display them via the browser interface will not be acceptable. A graphic selector list will allow users to select any graphics to which they have access. Graphic displays will automatically refresh with the latest change of values. Users will have the ability to command and override points from the graphic display as determined by their user accounts rights.
  - d) Point details – users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access rights.
  - e) Point Commanding – users will be able to override and command points they have access to via the web browser interface. Any commands or overrides initiated via the web browser interface will be written to the BAS central workstation activity log.
- 7. The web server licensing options will allow concurrent access by 10 browser connections.
  - 8. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the web access feature.
- I. DDC Controller Floor Level 2 Network
    - 1. This level communication shall support a family of application specific controllers and shall communicate with the network through DDC Controllers for transmission of global data.
  - J. DDC & HVAC Mechanical Equipment Controllers
    - 1. The DDC and HVAC Mechanical Equipment Controllers shall reside on the Building Level Network.
    - 2. DDC and HVAC Mechanical Equipment Controllers shall use the same programming language and tools. DDC and HVAC Mechanical Equipment Controllers which require different programming language or tools on a network are not acceptable.
    - 3. DDC and HVAC Mechanical Equipment Controllers which do not meet the functions specified are not acceptable.

K. DDC Controllers

1. DDC Controllers shall be a 16-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point I/O schedule. Each controller shall support a minimum of three Floor Level Application Specific Controller Device Networks.
2. Each DDC Controller shall have 72 512 Megabytes of memory with ECY and include 4 GB flash memory to support its own operating system and databases, including:
  - a. Control processes
  - b. Energy management applications
  - c. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
  - d. Historical/trend data for points specified
  - e. Maintenance support applications
  - f. Custom processes
  - g. Operator I/O
  - h. Dial-up communications
  - i. Manual override control using WAP for commissioning purpose
3. Each DDC Controller shall support firmware upgrades without the need to replace hardware.
4. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
5. DDC Controllers shall provide a RS-485 serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.
6. As indicated in the point I/O schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
  - a. Switches shall be mounted either within the DDC Controllers key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.
  - b. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

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7. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.
  8. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
  9. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
    - a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
    - b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
    - c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
    - d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
    - e. Isolation shall be provided at all peer-to-peer panel's AC input terminals to suppress induced voltage transients consistent with:
      - 1) IEEE Standard 587-1980
      - 2) UL 864 Supply Line Transients
      - 3) Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)
  10. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 60 days.
    - a. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
    - b. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.
  11. Provide a separate DDC Controller for each AHU or other HVAC system as indicated in Section 3.02. It is intended that each unique system be provided with its own point resident DDC Controller.
- L. HVAC Mechanical Equipment Controllers
1. HVAC Mechanical Equipment Controllers shall be a 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.
  2. Each HVAC Mechanical Controller shall have 72 Megabytes of memory to support its own operating system and databases, including:
    - a. Control processes

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- b. Energy management applications
  - c. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
  - d. Historical/trend data for points specified
  - e. Maintenance support applications
  - f. Custom processes
  - g. Operator I/O
  - h. Remote communications
3. HVAC Mechanical Equipment Controllers shall provide a RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.
  4. HVAC Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
  5. Each HVAC Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
  6. In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC Mechanical Equipment Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
    - a. Upon restoration of normal power, the HVAC Mechanical Equipment Controller shall automatically resume full operation without manual intervention.
    - b. Should HVAC Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.
- M. DDC and HVAC Mechanical Equipment Controller Resident Software Features
1. General:
    - a. The software programs specified in this Section shall be provided as an integral part of DDC and HVAC Mechanical Equipment Controllers and shall not be dependent upon any higher level computer for execution.
    - b. All points shall be identified by up to 30 character point name and 16 character point descriptor. The same names shall be used at the PC workstation.
    - c. All digital points shall have user defined two-state status indication (descriptors with minimum of eight characters allowed per state (i.e. summer/winter).

2. Control Software Description:
  - a. The DDC and HVAC Mechanical Equipment Controllers shall have the ability to perform the following pre-tested control algorithms:
    - 1) Two-position control
    - 2) Proportional control
    - 3) Proportional plus integral control
    - 4) Proportional, integral, plus derivative control
    - 5) Automatic tuning of control loops
3. DDC and HVAC Mechanical Equipment Controllers shall provide the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.
  - a. Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
    - 1) The SSTO program shall operate in both the heating and cooling seasons.
      - a) It shall be possible to apply the SSTO program to individual fan systems.
      - b) The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
    - 2) The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.
  - b. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
    - 1) It shall be possible to individually command a point or group of points.
    - 2) For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.
    - 3) The operator shall be able to define the following information:
      - a) Time, day
      - b) Commands such as on, off, auto, and so forth.
      - c) Time delays between successive commands.
      - d) There shall be provisions for manual overriding of each schedule by an appropriate operator.
    - 4) It shall be possible to schedule events up to one year in advance.
      - a) Scheduling shall be calendar based.



- b) Holidays shall allow for different schedules.
  - c) Enthalpy switchover (economizer) The Energy Management Control Software (EMCS) will control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover set point the EMCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.
  - d) Temperature-compensated duty cycling.
    - The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.
    - The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.
  - e) Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
  - f) Night setback control: The system shall provide the ability to automatically adjust setpoints for night control.
  - g) The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
    - PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
    - PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
    - If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.
    - Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.
4. DDC and HVAC Mechanical Equipment Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
- a. A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database shall support 30 character, English language point names, structured for searching and logs.

- b. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
  - c. DDC and HVAC Mechanical Equipment Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.
  - d. DDC and HVAC Mechanical Equipment Controller shall be capable of comment lines for sequence of operation explanation.
5. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
- a. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
  - b. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
  - c. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hours destinations) or based on priority.
  - d. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
  - e. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.

6. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.
  - a. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to seven days shall be provided. Each DDC and HVAC Mechanical Equipment Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a sufficient number of data samples. All trend data shall be available for transfer to a Workstation without manual intervention.
  - b. DDC and HVAC Mechanical Equipment Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
    - 1) Loop tuning shall be capable of being initiated either locally at the DDC and HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.
7. DDC and HVAC Mechanical Equipment Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.
8. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to access any data from or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers shall send alarm reports to multiple workstations without dependence upon a central or intermediate processing device. The peer to peer network shall also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.
9. The network shall allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

- N. Floor Level Network Application Specific Controllers (FEC)
1. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (FECs) through Floor Level LAN Device Networks.
  2. Each FEC shall operate as a stand alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each FEC shall be a microprocessor based, multi tasking, real time digital control processor. Each FEC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.
  3. Terminal Equipment Controllers:
    - a. Provide for control of each piece of equipment, including, but not limited to, the following:
      - 1) Exhaust Fans
      - 2) Fin Tube Radiation
      - 3) Convectors
      - 4) Radiant Heating Panels
      - 5) Unit Heaters, Cabinet Unit Heaters
    - b. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 psi pneumatic, 0-10v, allowing for interface to a variety of modulating actuators.
    - c. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the FLN, BLN or MLN is not acceptable.
- O. Local User Display
1. Where specified in the sequence of operation or points list, the controllers on the peer to peer building level network shall have a display and keypad for local interface. A keypad shall be provided for interrogating and commanding points in the controller.
  2. The display shall use the same security password and access rights for points in the display as is used in the associated controller.
  3. The LCD display shall be a minimum of a 2 line 40 character display.
  4. The LCD display shall include the full point name, value (numeric, digital or state text),
  5. point priority and alarm status on one screen.
  6. The LCD shall dynamically update the value, priority, and alarm status for the point being displayed.
  7. The display shall be mounted either on the door of the enclosure or remote from the controller.

- P. Personal Computer Operator Workstation Hardware
1. Personal computer operator workstations shall be provided for command entry, information management, system monitor, alarm management and database management functions. All real-time control functions shall be resident in the DDC Controllers to facilitate greater distribution, fault tolerance and reliability of the building automation control.
    - a. Provide workstation(s): Manufactured by Dell, HP, Lenovo or equal.
    - b. Workstation shall consist of a personal computer with minimum 10.0GB RAM, hard drive with 2 TB available space, video card capable of supporting 1024 × 768 resolution with a minimum of 32 Bit color (Windows 10), DVD-ROM Drive, mouse and 101-key enhanced keyboard. Personal computer shall be a Windows 10 Compatible PC and shall include a minimum latest generation Intel Core i7 3.40 GHz processor.
    - c. The PC monitor shall support a minimum display resolution of no less than 1900 X 1280 pixels and shall be minimum 19 in. LCD display. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.
    - d. Also provide separate file server with available storage capacity to accommodate trending 15 min. interval of each control point for a period of one year for data archives, minimum 1 TB capacity.
  2. Provide an HP LaserJet Pro 400 Color M451dn, Cannon, Brother or equal printer at each workstation location or on the network (Ethernet) for recording alarms, operator transactions and systems reports.
  3. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message. The alarm display shall provide a mechanism for the operator to sort alarms.
  4. Intranet/Internet access
    - a. Web Based Operator Interface
      - 1) The BAS shall provide a web based graphical interface that allows users to access the BAS data via the Internet, extranet, or Intranet. The interface shall use HTML based ASP pages to send and receive data from the BAS to a web browser.
      - 2) A web server computer will be supplied. The web server shall support browser access via Microsoft Internet Explorer 9.0 (or higher), or Navigator Netscape 6.0 (or higher).
      - 3) All information exchanged over Internet shall be optionally encrypted and secure via SSL (provided by Owner).
      - 4) Access to the web interface may be password protected. A users rights and privileges to points and graphics will be the same as those assigned at the BAS workstation. An option will exist to only allow users "read" access via the web browser, while maintaining "command" privileges via the BAS workstation.

- 5) Commissioning of the Web interface shall not require modification or creation of HTML or ASP pages. All graphics available at the BAS graphical workstation shall be available to users via a web browser.
- 6) The web-based interface shall provide the following functionality to users, based on their access and privilege rights:
  - a) Logon Screen – allows the user to enter their user name, password and Domain name for logging into the web server.
  - b) Alarm Display – a display of current BAS alarms to which the user has access will be displayed. Users will be able to acknowledge and erase active alarms, and link to additional alarm information including alarm messages, and informational and memo text. Any alarm acknowledgements initiated through the web interface will be written to the BAS central workstation activity log.
  - c) Graphic Display – Display of system graphics, including animated motion, available in the BAS workstation will be available for viewing over the web browser. Software that requires creation of dedicated “web” graphics in order to display them via the browser interface will not be acceptable. A graphic selector list will allow users to select any graphics to which they have access. Graphic displays will automatically refresh with the latest change of values. Users will have the ability to command and override points from the graphic display as determined by their user accounts rights.
  - d) Point details – users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access rights.
  - e) Point Commanding – users will be able to override and command points they have access to via the web browser interface. Any commands or overrides initiated via the web browser interface will be written to the BAS central workstation activity log.
- 7) The web server licensing options will allow concurrent access by a minimum of 10 browser connections.
- 8) Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the web access feature.

Q. Operators Laptop

1. A Lap Top Operators Terminal shall be provided for operator readout of system variables, override control and adjustment of control parameters and display graphics as called for in paragraphs following. Computer specification shall be similar to fixed station computer in Paragraph Q.

2. Functionality to include ability to automatically display a sequential all point summary and a sequential alarm summary. The Lap Top shall also allow display and/or changing of digital point state, analog point value, time and date, application and DDC parameters, analog limits, time schedules, runtime counts and limits, daylight savings time changeover, time/event initiation, and programmable offset values. The Lap Top shall allow access into DCP initialization routines and diagnostics and enable/disable of points, initiators and programs, all similar to the fixed computer. Laptop shall have a minimum 15 in. color screen, 4GB ram, 500GB hard drive and Windows 10 Professional operating system.

R. Workstation Operator Interface

1. Basic Interface Description

- a. Operator workstation interface software shall minimize operator training through the use of user-friendly and interactive graphical applications, 30-character English language point identification, on-line help, and industry standard Windows application software. Interface software shall simultaneously communicate with existing system and share data between the dedicated, modem autodial, and Ethernet-connected building level networks. The software shall provide, as a minimum, the following functionality:
  - 1) Real-time graphical viewing and control of the BAS environment
  - 2) Reporting
  - 3) Scheduling and override of building operations
  - 4) Collection and analysis of historical data
  - 5) Point database editing, storage and downloading of controller databases.
  - 6) Utility for combining points into logical Point Groups. The Point Groups shall then be manipulated in Graphics, trend graphs and reports in order to streamline the navigation and usability of the system.
  - 7) Alarm reporting, routing, messaging, and acknowledgment
  - 8) "Collapsible tree," dynamic system architecture diagram application:
    - a) Showing the real-time status and definition details of all workstations and devices on a management level network
    - b) Showing the real-time status and definition details of all DDC and HVAC Mechanical Controllers at the building level
    - c) Showing the status and definition details of all field-level application controllers
  - 9) Definition and construction of dynamic color graphic displays.
  - 10) Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
  - 11) On-screen access to User Documentation, via online help or PDF-format electronic file.
  - 12) Automatic database backup at the workstation for database changes initiated at DDC Controller operator interface terminals.

- b. Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation. Selection of applications within the workstation software shall be via a graphical toolbar menu – the application toolbar menu shall have the option to be located in a docked position on any of the four sides of the visible desktop space on the workstation display monitor, and the option to automatically hide itself from the visible monitor workspace when not being actively manipulated by the user.
- c. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BAS software shall run on a Windows 7 Professional bit operating system. System database parameters shall be stored within an object-oriented database, which is compliant with the Open Database Connectivity (ODBC) or Structured Query Language (SQL) standards. Standard Windows applications shall run simultaneously with the BAS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information
  - 1) Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via adjustable user-sized windows. Operator shall be able to drag and drop information between the following applications, reducing the number of steps to perform a desired function (e.g., Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend on the desired point):
    - a) Dynamic color graphics application
    - b) Alarm management application
    - c) Scheduling application
    - d) Dynamic trend graph data plotter application
    - e) Dynamic system architecture diagram application
    - f) Control Program and Point database editing applications
    - g) Reporting applications
  - 2) Report and alarm printing shall be accomplished via Windows Print Manager, allowing use of network printers.
- d. Operator-specific password access protection shall be provided to allow the administrator/manager to limit users' workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation logged onto (up to 999 user accounts shall be supported). The administrator/manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BAS workstation application. And each BAS workstation user account shall use a Windows 10 user account as a foundation.



- e. Dynamic Color Graphics application shall include the following:
  - 1) Must include graphic editing and modifying capabilities
  - 2) A library of standard control application graphics and symbols must be included
  - 3) Must be able to command points directly off graphics application
  - 4) Graphic display shall include the ability to depict real-time point values dynamically with animation, picture/frame control, symbol association, or dynamic informational text-blocks.
  - 5) Navigation through various graphic screens shall be optionally achieved through a hierarchical "tree" structure
  - 6) Graphics viewing shall include zoom capabilities
  - 7) Graphics shall automatically display the HAND status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
  - 8) Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls), internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.
- f. Reports shall be generated on demand or via pre-defined schedule, and directed to CRT displays, printers or file. As a minimum, the system shall allow the user to easily obtain the following types of reports:
  - 1) A general listing of all or selected points in the network
  - 2) List of all points currently in alarm
  - 3) List of all points currently in override status
  - 4) List of all disabled points
  - 5) List of all points currently locked out
  - 6) List of user accounts and access levels
  - 7) List all weekly schedules and events
  - 8) List of holiday programming
  - 9) List of control limits and deadbands
  - 10) Custom reports from 3rd party software
  - 11) System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points
  - 12) List of programs
  - 13) List of point definitions
  - 14) List of logical point groups
  - 15) List of alarm strategy definitions
  - 16) List of DDC Control panels
  - 17) Point totalization report
  - 18) Point Trend data listings
  - 19) Initial Values report

- 20) User activity report
- g. Scheduling and override
- h. Provide a calendar type format for simplification of time and date scheduling and overrides of building operations. Schedule definitions reside in the PC workstation, DDC Controller, and HVAC Mechanical Equipment Controller to ensure time equipment scheduling when PC is off-line -- PC is not required to execute time scheduling. Provide override access through menu selection, graphical mouse action or function key. Provide the following capabilities as a minimum:
  - 1) Weekly schedules
  - 2) Zone schedules
  - 3) Event schedules – an event consists of logical combinations of equipment and/or zones
  - 4) Report schedules
  - 5) Ability to schedule for a minimum of up to 365 days in advance
  - 6) Additionally, the scheduling application shall:
    - a) Provide filtering capabilities of schedules, based on name, time, frequency, and schedule type (event, zone, report)
    - b) Provide sorting capabilities of schedules, based on name, time and type of schedule (zone, event, report)
    - c) Provide searching capabilities of schedules based on name – with wildcarding options
- i. Collection and Analysis of Historical Data
  - 1) Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals (up to four time-based definitions per point) or change of value, both of which shall be user-definable. Trend data shall be collected stored on hard disk for future diagnostics and reporting. Automatic Trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of zones, events, and reports. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
  - 2) Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of selected points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.
- j. The ATC contractor shall provide an additional 80 hours of ATC/BMS system programming time to assist the owner/engineer with customized programming of the ATC/BMS system due to any changes and/or modifications.

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2. Dynamic Color Graphic Displays
- a. Create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units and hot water boiler systems, and room level terminal units, shall be provided by the BAS contractor as indicated in the point I/O schedule of this specification to optimize system performance, analysis and speed alarm recognition.
  - b. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, point alarm association, or text-based commands. Graphics software shall permit the importing of Autocad or scanned pictures for use in the system.
  - c. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations within the system schematics or graphic floor plan displays, and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.
    - 1) Provide the user the ability to display real-time point values by animated motion or custom picture control visual representation. Animation shall depict movement of mechanical equipment, or air or fluid flow. Picture Control shall depict various positions in relation to assigned point values or ranges. A library (set) of animation and picture control symbols shall be included within the workstation software's graphics application. Animation shall reflect, ON or OFF conditions, and shall also be optionally configurable for up to five rates of animation speed.
    - 2) Sizable analog bars shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.
    - 3) Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.
    - 4) Equipment state or values can be changed by clicking on the associated point block or graphic symbol and selecting the new state (on/off) or setpoint.
    - 5) State text for digital points can be user-defined up to eight characters.
  - d. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.
  - e. Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls), internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.
  - f. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
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- g. Off the shelf graphic software, html web-based graphic software shall be provided to allow the user to add, modify or delete system graphic background displays.
  - h. A clipart library of HVAC application and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams. The user shall have the ability to add custom symbols to the clipart library. The clipart library shall include a minimum of 400 application symbols. In addition, a library consisting of a minimum of 700 graphic background templates shall be provided.
  - i. The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.
3. System Configuration & Definition
- a. A "Collapsible tree," dynamic system architecture diagram/display application of the site-specific BAS architecture showing status of controllers, PC workstations and networks shall be provided. This application shall include the ability to add and configure workstations, DDC Controllers or HVAC Mechanical Equipment controllers, as well as 3rd-party integrated components. Symbols/Icons representing the system architecture components shall be user-configurable and customizable, and a library of customized icons representing 3rd-party integration solutions shall be included. This application shall also include the functionality for real-time display, configuration and diagnostics of dial-up modems to DDC Controllers.
  - b. Network wide control strategies shall not be restricted to a single DDC Controller or HVAC Mechanical Equipment controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.
  - c. Provide automatic backup and restore of all DDC controller and HVAC Mechanical Equipment controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller or HVAC Mechanical Equipment Controller. Changes made at the user-interface of DDC Controllers or HVAC Mechanical Equipment Controllers shall be automatically uploaded to the workstation, ensuring system continuity.
  - d. System configuration, programming, editing, graphics generation shall be performed on-line. If programming and system back-up must be done with the PC workstation off-line, the BAS contractor shall provide at least 2 operator workstations.

- e. Point database configuration shall be available to the user within a dedicated point database editor application included in the workstation software. The editor shall allow the user to create, view existing, modify, copy, and delete points from the database. The point editor shall also allow the user to configure the alarm management strategy for each point. The editor shall provide the option for editing the point database in an online or offline mode with the DDC Controllers.
    - 1) The workstation software shall also provide the capability to perform bulk modification of point definition attributes to a single or multiple user-selected points. This function shall allow the user to choose the properties to copy from a selected point to another point or set of points. The selectable attributes shall include, but are not limited to, Alarm management definitions and Trend definitions.
4. Alarm Management
- a. Alarm Routing shall allow the user to send alarm notification to selected printers or workstation location(s) based on time of day, alarm severity, or point type.
  - b. Alarm Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each alarm point: name, value, alarm time and date, alarm status, priority, acknowledgement information, and alarm count. Each alarm point or priority shall have the ability to sound a discrete audible notification.
  - c. Alarm Display shall have the ability to list and sort the alarms based on alarm status, point name, ascending or descending alarm time.
  - d. Directly from the Alarm Display, the user shall have the ability to acknowledge, silence the alarm sound, print, or erase each alarm. The interface shall also have the option to inhibit the erasing of active acknowledged alarms, until they have returned to normal status. The user shall also have the ability to command, launch an associated graphic or trended graphical plot, or run a report on a selected alarm point directly on the Alarm Display.
  - e. Each alarm point shall have a direct link from the Alarm Display to further user-defined point informational data. The user shall have the ability to also associate real-time electronic annotations or notes to each alarm.
  - f. Alarm messages shall be customizable for each point, or each alarm priority level, to display detailed instructions to the user regarding actions to take in the event of an alarm. Alarm messages shall also have the optional ability to individually enunciate on the workstation display via a separate pop-up window, automatically being generated as the associated alarm condition occurs.
  - g. Alarm Display application shall allow workstation operators to send and receive real-time messages to each other, for purposes of coordinating Alarm and BAS system management.
  - h. Remote notification of messages
    - 1) Workstation shall be configured to send out messages to numeric pagers, alphanumeric pagers, phones (via text to speech technology), SMS (Simple Messaging Service, text messaging) Devices, and email accounts based on a point's alarm condition.

- 2) There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices which can receive messages from the system.
- 3) On a per point basis, system shall be configurable to send messages to an individual or group and shall be configurable to send different messages to different remote devices based on alarm message priority level.
- 4) Remote devices may be scheduled as to when they receive messages from the system to account for operators' work schedules.
- 5) System must be configurable to send messages to an escalation list so that if the first device does not respond, the message is sent on to the next device after a configurable time has elapsed.
- 6) Message detail shall be configurable on a per user basis.
- 7) During a "flood" of alarms, remote notification messages shall have the ability to optimize several alarms into an individual remote notification message.
- 8) Workstation shall have the ability to send manual messages allowing an operator to type in a message to be sent immediately.
- 9) Workstation shall have a feature to send a heartbeat message to periodically notify users that they have communication with the system.

S. Field Devices

1. Provide instrumentation as required for monitoring, control or optimization functions.
2. Room Temperature Sensors
  - a. All temperature sensors shall be BACnet compatible network type. Auditorium, Stage and Office areas shall be provided with digital combination room sensors for temperature, humidity and CO2 (two sensors may be provided in lieu of one) and shall have LCD display, day / night override button, and setpoint slide adjustment. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment. All other areas/spaces including but not limited to classrooms and teaching room areas shall have combination room sensors for temperature, humidity and CO2 (two sensors may be provided in lieu of one) and shall have day / night override button, and setpoint slide adjustment options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment. Public areas such as corridors, entry areas, vestibules, restrooms shall have chrome cover plate without adjustment or override occupied/unoccupied capability. Sensors located in Gymnasiums, Alternate PE, Tech Shops, Kitchen and Locker rooms shall be provided with tamper proof guard.

Temperature monitoring range	+20/120 deg. F -13 deg. to 49 deg. C)
Output signal	Changing resistance

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	Accuracy at Calibration point	+0.5 deg. F (+/- 0.3 deg. C)
	Set Point and Display Range	55 deg. to 95 deg. F (13 deg. to 35 deg. C)
b.	Liquid immersion temperature:	
	Temperature monitoring range	+30/250 deg. F (-1 deg. /121 deg. C)
	Output signal	Changing resistance
	Accuracy at Calibration point	+0.5 deg. F (+/-0.3 deg. C)
c.	Duct (single point) temperature:	
	Temperature monitoring range	+20/120 deg. F (-7 deg. /49 deg. C)
	Output signal	Changing resistance
	Accuracy at Calibration point	+0.5 deg. F (+/-0.3 deg. C)
d.	Duct Average temperature:	
	Temperature monitoring range	+20 deg.+120 deg.F(-7 deg./+49 deg. C)
	Output signal	4 – 20 mA DC
	Accuracy at Calibration point	+0.5 deg. F (+03 deg. C)
	Sensor Probe Length	25 ft. L (7.3m)
e.	Outside air temperature:	
	Temperature monitoring range	-58deg.+122deg.F(-50deg.Cto 50deg.C)
	Output signal	4 – 20 mA DC
	Accuracy at Calibration point	+0.5 deg. F (+/-0.3 deg. C)
3.	Liquid Differential Pressure Transmitter	
	Ranges	0-5/30 in. H2O 0-25/150 in. H2O 0-125/750 in. H2O
	Output	4 – 20 mA DC
	Calibration Adjustments	Zero and span
	Accuracy	+/-0.2 percent of span
	Linearity	+/-0.1 percent of span
	Hysteresis	+/-0.05 percent of span
4.	Differential pressure:	
a.	Unit for fluid flow proof shall be Penn P74.	
	Range	8 to 70 psi
	Differential	3 psi

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Maximum differential pressure	200 psi
Maximum pressure	325 psi
b. Unit for air flow settings.	
c. Set point ranges:	0.5 in. WG to 1.0 in. WG (124.4 to 248.8 Pa)
	1.0 in. WG to 12.0 in. WG (248.8 to 497.6 Pa)
5. Static pressure sensor:	
Range	0 to .5 in.WG (0 to 124.4 Pa)
	0 to 1 in.WG (0 to 248.8 Pa)
	0 to 2 in. WG (0 to 497.7 Pa)
	0 to 5" in.WG (0 to 1.2 kPa)
	0 to 10" WG (0 to 2.5 kPa)
Output Signal	4 – 20 mA VDC
Combined static error	0.5 percent full range
Operating Temperature	-40 deg. to 175 deg. F (-40 deg. C to 79.5 deg. C)
6. Air Pressure Sensor:	
Range:	0 to 0.1 in. water (0 to 24.9 Pa)
	0 to 0.25 in. water (0 to 63.2 Pa)
	0 to 0.5 in. water (0 to 124.5 Pa)
	0 to 1.0 in. water (0 to 249 Pa)
	0 to 2.0 in water 90 to 498 Pa)
	0 to 5.0 in. water (0 to 1.25 kPa)
	0 to 10.0 in. water (0 to 2.49 kPa)
Output signal	4 to 20 mA
Accuracy	+1.0 percent of full scale
7. Humidity Sensors:	All room/zone humidity sensors shall be BACnet compatible network type.
Range	0 to 100 percent RH
Sensing Element	Bulk Polymer
Output Signal	4 – 20 mA DC



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Accuracy	At 77 deg. F (25 deg. C) + 2 percent RH
Humidistat:	
Range	0 to 100 percent RH
Sensing Element	Bulk Polymer
Output Signal	4 – 20 mA DC
Accuracy	At 77 deg. F(25 deg. C) + 2 percent RH

8. Insertion Flow Meters (Equal to Onicon F-5300)

Sensing Method	Impedance Sensing
Accuracy	+ 2 percent of Actual Reading
Maximum Operating Pressure	400 PSI
Output Signal	4 – 20 mA
Bi-directional where required.	

9. Pressure to Current Transducer

Range	3 to 15 psig (21 to 103 kPa) or 3 to 30 psig (21 to 207 kPa)
Output signal	4 – 20 mA
Accuracy	+ 1 percent of full scale (+ 0.3 psig)

10. Carbon Dioxide Sensor : All room/zone CO2 & duct mounted sensors shall be BACnet compatible network type and shall have a minimum 5 year calibration period.

Range	0 to 1500 ppm
Accuracy	20+ ppm

CO2 sensors located in gymnasiums and locker rooms shall be provided with tamper proof guard.

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11. Control Valves (all control valves shall have electric actuators with position feedback to provide confirmation of valve position).

a. Electric Control

Rangeability	40:1
Flow Characteristics	Modified. Equal percentage
Control Action	Normal open for hot water and normal closed for cooling
Medium	Steam, water, glycol
Body Type	Screwed ends 2 in. and smaller, flanged Valves 2½ in. and larger
Body Material	Bronze
Body Trim	Bronze
Stem	Stainless Steel
Actuator	0-10 VDC, 4-20 MA or 2 position  24 VAC/120VAC – Modulating for all hot water and chilled water valves with a GPM value of 1 or above, 2 position valves for all GPM's under 1.

- b. All automatic temperature control valves in water lines shall be provided with Characterized throttling plugs and shall be sized for minimum 25 percent of the system pressure drop or three psi, whichever is less.
- 1) Positive positioning relays shall be provided on pneumatic control when required to provide sufficient power for sequencing.
  - 2) Two position valves shall be line size.

12. Damper Actuators

- a. Electric control shall be direct coupled actuators with position feedback to BMS.
- b. Damper actuators shall be Brushless DC Motor Technology with stall protection, bi-directional, fail safe spring return, all metal housing, manual override, independently adjustable dual auxiliary switch.
  - 1) The actuator assembly shall include the necessary hardware and proper mounting and connection to a standard ½ in. diameter shaft or damper blade.
- c. Actuators shall be designed for mounting directly to the damper shaft without the need for connecting linkages.

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- d. All actuators having more than 100 lb-in torque output shall have a self-centering damper shaft clamp that guarantees concentric alignment of the actuator's output coupling with the damper shaft. The self-centering clamp shall have a pair of opposed "v" shaped toothed cradles; each having two rows of teeth to maximize holding strength. A single clamping bolt shall simultaneously drive both cradles into contact with the damper shaft.
  - e. All actuators having more than a 100 lb-in torque output shall accept a 1 in. diameter shaft directly, without the need for auxiliary adapters.
  - f. All actuators shall be designed and manufactured by Belimo or approved equal using ISO900 registered procedures, and shall be Listed under Standards UL873 and CSA22.2 No. 24-93 I.
- T. Ultra-Low Leakage HVAC Control Dampers
- 1. Model: CD60 as manufactured by Ruskin Company or equal.
  - 2. Ratings:
    - a. Leakage: Damper shall have a maximum leakage of 3 cfm/sq. ft. @1 inch wg. and shall be AMCA licensed as Class 1A.
    - b. Size: Damper widths from 12 inches (305 mm) to 60 inches (1524 mm) meeting Class 1A as scheduled or required.
    - c. Differential Pressure: Damper shall have a maximum differential pressure rating of 13 in. w.g. (3.2 kPa) for a 12 inches (305 mm) blade.
    - d. Velocity: Damper shall have a maximum velocity rating of 6,000 fpm (1,829 m/min).
    - e. Temperature: Damper shall be rated for -72 to 275 degrees F (-58 to 135 degrees C) or as required for its intended application (ie. smoke rated, high temperature rated, fire rated, etc.)
  - 3. Construction:
    - a. Frame: 5 inches x minimum 16 gage (127 x minimum 1.6 mm) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage (2.3 mm) U-channel.
    - b. Blades:
      - 1) Style: Airfoil-shaped, single-piece.
      - 2) Action: Parallel.
      - 3) Action: Opposed.
      - 4) Orientation: Horizontal.
      - 5) Orientation: Vertical with thrust washers.
      - 6) Material: Minimum 14 gage (2.0 mm) equivalent thickness, galvanized steel.
      - 7) Width: Nominal 6 inches (152 mm).
    - c. Bearings: Self-lubricating stainless steel sleeve, turning in extruded hole in frame.

- d. Seals:
    - 1) Blade: Extruded Ruskiprene TPV type for ultra-low leakage from -76 to 350 degrees F (-60 to 177 degrees C). Mechanically attached to blade edge.
    - 2) Jamb: Flexible metal compression type.
  - e. Linkage: Concealed in frame.
  - f. Axles: Minimum 1/2 inches (13 mm) diameter plated steel, hex-shaped, mechanically attached to blade.
  - g. Mounting: Vertical.
  - h. Mounting: Horizontal.
  - i. Finish: Mill galvanized.
  - j. Finish: Stainless steel.
- U. Meters: Meters shall be provided to monitor and trend the energy consumed by the HVAC (heating, cooling, ventilation, fans) and Hot water (Heating and Domestic) serving the building. Provide the following meters (or connection to meters) and network these devices into the Building Management System.
- 1. Provide hydronic BTU Energy Meters (Ultrasonic, strap on type flow meters and temperature sensors) for the following systems. Hydronic system energy data obtained from meters and sensors shall be input to the building automation system for calculating, trending and storing energy consumption information of the following systems:
    - a. Heating Hot Water
    - b. Cold Water Make-Up (Building Water Use)
    - c. Domestic Hot Water
  - 2. Provide all necessary components and accessories required for connection to main electrical KYZ pulse consumption meters (kWh). Meters shall be provided by Division 260010. Refer to Electrical Drawings for meter location.
  - 3. The energy consumption data obtained from all the meters shall be stored by the building automation system which shall export this data in real-time fashion to a software program such as "Building Dashboard" by Lucid Design Group Inc. which shall be provided by the ATC Contractor for public viewing on a digital kiosk by I&E or equal.
  - 4. The ATC Contractor shall provide and program a digital interactive kiosk which shall display building graphics, energy consumption meters, HVAC equipment, outdoor air temperature, humidity, wind speed, wind direction, and barometric pressure. Provide 60" LCD screen model podium HD manufactured by Industrial Computing Products from I&E or equal. Provide all necessary programming wiring and software for a complete and functional interactive kiosk.
  - 5. Domestic hot water consumption shall be determined and calculated by the ATC contractor. Relays shall be installed on the domestic water heater burner to calculate usage. ATC Contractor shall provide relays and programming required to achieve consumption.

6. Sensors to monitor building natural gas consumption. Gas meters shall be furnished and installed by the Plumbing contractor. The ATC contractor shall provide control wiring from the meter to the BMS.
7. Flow meters for cold water consumption will be installed by the Plumbing Contractor and furnished and wired to the BMS by the ATC Contractor.

V. Miscellaneous Devices

1. Thermostats (Stand-alone electric type - only where specified or indicated on drawings)
  - a. Room thermostats shall be of the gradual acting type with adjustable sensitivity.
  - b. They shall have a bi-metal sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required.)
  - c. Thermostats shall be arranged for either horizontal or vertical mounting.
  - d. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.
  - e. Mount the thermostat covers with tamper-proof socket head screws.
2. Freezestats:
  - a. Install freezestats on each coil that mixes outside and return air (air handling units, fan coils, unit ventilators) and provide protection for every square foot of coil surface area with one linear foot of element per square foot of coil.
    - 1) Upon detection of low temperature, the freezestats shall stop the associated supply fans and return the automatic dampers to their normal position close outside air dampers and open coil valve for full flow. Provide manual reset.
3. Firestats:
  - a. Provide manual reset, fixed temperature line voltage type with a bi-metal actuated switch.
    - 1) Switch shall have adequate rating for required load.
4. Electronic Airflow Measurement Stations and Transmitters (Where indicated on Control Drawings).
  - a. Provide air flow monitoring stations as shown on drawings.
  - b. Duct and Plenum Mounted Air Flow Measuring Stations.
    - 1) Sensor probes shall be constructed of gold anodized, 6063 aluminum alloy tube. Sensor probe mounting brackets shall be constructed of 304 stainless steel.
    - 2) Each sensor node shall be provided with two bead-in-glass, hermetically sealed thermistors potted in a marine grade waterproof epoxy with sensor housing constructed of glass-filled polypropylene.
    - 3) Sensor nodes shall operate from -20 to 160 degrees Fahrenheit. Sensor nodes shall be capable of reading velocity on a scale of 0-5,000 fpm with an accuracy of +/- 2% of actual reading.

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- 4) A remotely located microprocessor-based transmitter shall be provided for each measurement location, local readout shall be provided on unit. The transmitter shall be provided with two field selectable analog outputs (0-10 VDC or 4-20 mA) as well as an isolated RS-485 BACnet network connection.
  - 5) Provide Ebtron GTx116-P+ or Paragon FE-1000.
- c. Fan Inlet Style Air Flow Measuring Stations
- 1) Provide fan inlet and outdoor airflow measuring devices for air handling units as shown on drawings. Each airflow measuring device shall consist of multiple measuring probes.
  - 2) Fan inlet probes shall not be mounted in the smallest diameter of the inlet of the fan, the probes shall not have a negative effect on the performance of the fan or the noise generated by the fan. In instances where access to the air handling units' fans is restricted utilize duct mounted airflow measuring probes. A remotely located microprocessor-based transmitter shall be provided for each measurement location, local readout shall be provided on unit. The transmitter shall be provided with two field selectable analog outputs (0-10 VDC or 4-20 mA) as well as an isolated RS-485 BACnet network connection.
  - 3) ATC contractor shall consult factory trained manufacturer's representative as part of this contract to assist in design and to inspect all outside air measurement installations and assist in calibrating and adjusting the air flow measuring stations as required to meet final balancing setting to provide accurate BMS monitoring and control.
  - 4) Provide Ebtron GTx108-F or Paragon Model FE-1050.
5. Current Sensing Relay:
- a. Provide solid-state, adjustable, current operated relay. Provide a relay which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.
  - b. Adjust the relay switch point so that the relay responds to motor operation under load as an "on" state and so that the relay responds to an unloaded running motor as an "off" state. A motor with a broken belt is considered an unloaded motor.
  - c. Provide for status device for all fans and pumps.
- W. Manufacturers: The Automatic Temperature Control System shall be manufactured by:
1. American Energy Management (AEM)
  2. Johnson Controls
  3. Siemens
  4. Or equal

### **PART 3 - EXECUTION**

#### **3.1 ATTIC STOCK**

##### **A. Rooftop Units**

1. Four additional complete extra sets of pre and final filters for each RTU for attic stock. All these filters indicated above including the four sets of attic stock are additional to those provided for flush out and indoor air quality requirements per LEED requirements.
2. Provide one spare set of belts for each belt-driven air handling unit.
3. Obtain receipt from Owner that attic stock provided.

##### **B. Power and Gravity Ventilators**

1. Furnish to Owner, with receipt, one spare set of belts for each belt driven power ventilator.

##### **C. Ductwork Accessories**

1. Furnish extra fusible links to owner, one link for every 10 installed of each temperature range; obtain receipt.

##### **D. Unit Heaters**

1. Furnish to Owner, with receipt, (2) spare sets of filters per each unit.

##### **E. Condensate Discharge Pumps**

1. Furnish to Owner, with receipt, (10) new condensate pumps to attic stock.

#### **3.2 CUTTING AND PATCHING**

##### **A. Penetrations through construction as required for the Work of this Section:**

1. Coring: Perform all coring for required work.
2. Notify Masonry Sub-Contractor of exact locations and sizes for openings required in masonry, to be executed under Section 042000 – Unit Masonry, utilizing lintels furnished per Section 055000 – Metal Fabrications.
3. Cut openings in new and existing non-masonry construction where required for penetrations. All cutting shall conform to the requirements of Section 017329 – CUTTING AND PATCHING, and 024119 – DEMOLITION.
4. Refer to Section 024119 – DEMOLITION for restrictions on all alterations to structural elements.

##### **B. Patching at penetrations through construction as required for the Work of this Section:**

1. Notify Masonry Sub-Contractor when plumbing work is complete at penetrations through masonry construction, and ready for patching under Section 042000 – UNIT MASONRY.
2. Notify appropriate Sub-Contractors when plumbing work is complete at penetrations through non-masonry construction, and ready for patching under Sections in Division 09 - FINISHES.

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### 3.3 INSTALLATION OF VALVES

- A. Examine valve interior through the end ports, for cleanliness, freedom from foreign matter and corrosion. Remove special packing materials, such as blocks used which prevents disc movement during shipping and handling.
- B. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the position in which it was shipped.
- C. Examine threads on both the valve and the mating pipe for form (out-of-round or local indentation) and cleanliness.
- D. Examine mating flange faces for conditions which might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size and material, and for freedom from defects and damage.
- E. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.
- F. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select valves with the following ends or types of pipe/tube connections:
  - 1. Copper Tube 2 in. and smaller (Heating Hot Water): Solder ends.
  - 2. Steel Pipe Sizes 2 in. and smaller: Threaded or grooved-end.
  - 3. Steel Pipes Sizes 2-1/2 in. and larger: Grooved-end or welded.
- G. Valve Installation
  - 1. Locate valves for easy access and provide separate support where necessary.
  - 2. Install valves and unions for each fixture and item of equipment in a manner to allow equipment removal without system shut-down. Unions are not required on flanged devices.
  - 3. Install valves in horizontal piping with the stem at or above the center of the pipe.
  - 4. Install isolation valves at all branch supply and return piping lines which serve more than two pieces of terminal heating equipment.
  - 5. Installation of Check Valves: Install for proper direction of flow as follows:
    - a. Swing Check Valves: Install in horizontal position with hinge pin level.
    - b. Wafer Check Valves: Install between 2 flanges in horizontal or vertical position.
    - c. Lift Check Valves: Install in piping line with stem upright and plumb.
- H. Threaded Connections
  - 1. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
  - 2. Align threads at point of assembly.
  - 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).



4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
- I. Flanged Connections
    1. Align flanges surfaces parallel.
    2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using a torque wrench.
  - J. Grooved Connections
    1. Installation shall be in accordance with the latest published instructions from the manufacturer.
  - K. Field Quality Control
    1. Testing: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks; replace valve if leak persists.
  - L. Adjusting and Cleaning
    1. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare to receive painting or insulation.
- 3.4 INSTALLATION OF METERS AND GAGES
- A. Installation of Temperature Gages
    1. General: Install temperature gages in vertical upright position, and tilted so as to be easily read by observer standing on floor.
    2. Temperature Gage Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure Cap.
  - B. Installation of Pressure Gages
    1. General: Install pressure gages in piping tee with pressure gage located on pipe at most readable position.
    2. Pressure Gage Cocks: Install in piping tee with snubber. Install siphon for steam pressure gages.
    3. Pressure Gage Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.
  - C. Installation of Flow Measuring Fittings
    1. General: Install flow measure fittings in piping systems located in accessible locations.
  - D. Adjusting and Cleaning
    1. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.
    2. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked or broken windows; repair any scratched or marred surfaces with manufacturer's touch-up paint.

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### 3.5 INSTALLATION OF HANGERS & ATTACHMENTS

- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and drawing VS.1.
- B. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- C. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors, and other building structural attachments.
- D. Prior to installation of hangers, supports, anchors, and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purposes of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.
- E. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the tops of inserts.
- F. Install hangers, supports, clamps, and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
  - 1. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
  - 2. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.
  - 3. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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4. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
  5. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
  6. Insulated Piping: Comply with the following installation requirements:
    - a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
    - b. Shields: For pipe sizes up to and including 4 in. provide heavy gage shield at each hanger point.
    - c. Saddles: For all pipe sizes over 4 in. provide saddle at each hanger point. Completely fill void in saddle with loose insulation.
  - G. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer for loading and stresses to connected equipment.
  - H. Fabricate and install anchor by welding steel shapes, plates, and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.
  - I. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
  - J. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.
  - K. Concrete housekeeping bases shall be provided by General Contractor for all floor-mounted equipment. Size bases to extend minimum of 4 in. beyond equipment base in any direction; and 4 in. above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.
  - L. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.
  - M. Adjusting and Cleaning:
    1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
    2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
    3. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

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### 3.6 INSTALLATION OF MECHANICAL IDENTIFICATION

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces; install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. General: Install pipe markers of the following type on each system indicated to receive identification, and include arrows to show normal direction of flow:
  - 1. Plastic pipe markers, with application system as indicated. Install on pipe insulation segment where required for hot non-insulated pipes.
- C. Locate pipe markers and color bands as follows wherever piping is in or above occupied spaces or corridors, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
  - 1. Near each valve and control device.
  - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
  - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
  - 4. At access doors, manholes and similar access points which permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced intermediately at maximum spacing of 50 ft. along each piping run, except reduce spacing to 25 ft. in congested areas of piping and equipment.
  - 7. On piping above removable acoustical ceilings.
- D. Valve Identification:
  - 1. General: Provide valve tag on every valve, cock, and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
  - 2. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.
- E. Mechanical Equipment Identification:
  - 1. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device.
  - 2. Lettering Size: Minimum 1/4 in. high lettering for name of unit where viewing distance is less than 2 ft. – 0 in., 1/2 in. high for distances up to 6 ft. – 0 in. and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.
- F. Ductwork Identification:
  - 1. Install or apply labels per manufacturer's recommendations.

2. Install in locations where it can be viewable by personnel.

G. Adjusting and Cleaning:

1. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
2. Cleaning: Clean face of identification devices, and glass frames of valve charts.

### 3.7 INSTALLATION OF MECHANICAL INSULATION

A. Installation of Piping Insulation:

1. Insulation
2. Composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated. Do not cover calibrated balance valves until testing adjusting and balancing has been completed. Omit insulation on hot piping within radiation enclosures which serve the zone: hot water passing through the zone must be insulated or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan. (Couplings in mechanical grooved systems will be insulated.)
3. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
4. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance tests.
5. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
6. Clean and dry pipe surfaces prior to insulating. Butt installation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
7. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
8. Cover valves, fittings and similar items in each piping system with equivalent thickness and c
9. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
10. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3 in. wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 in. wide vapor barrier tape or band.

B. Installation of Ductwork Insulation:

1. General: Do not insulate ductwork until ductwork has been sealed successfully, pressure tested, and approved for application of insulation by engineer or commissioning agent. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
2. Install insulation materials with smooth and even surfaces.

3. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
4. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.
5. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
6. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

C. Installation of Equipment Insulation:

1. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
2. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.
3. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
4. Do not apply insulation to equipment, breechings, or stacks while hot.
5. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.
6. Coat insulated surfaces with layers of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
7. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2 in. Apply over vapor barrier where applicable.
8. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruption of insulation.
9. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

D. Protection and Replacement:

1. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
2. Protection; Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

### 3.8 INSTALLATION OF GREASE DUCT INSULATION

A. EXAMINATION

1. Do not begin installation until substrates have been properly prepared.
2. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

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3. Coordinate installation of the Thermal Ceramics FastDoor XL access door between sheet metal and insulation trades.

B. PREPARATION

1. Remove dirt and dust from surfaces of openings and items penetrating rated floors and rated walls.

C. INSTALLATION

1. Install FireMaster FastWrap XL or Pyroscat Duct Wrap XL in direct contact with the ductwork in accordance with manufacturer's instructions, applicable laboratory listings and building code reports, and referenced standards. For additional complex duct design installation recommendations, see the Thermal Ceramics' complete installation guide.
2. Install two layers of FireMaster FastWrap XL or Pyroscat Duct Wrap XL for zero clearance and a 1 and 2 hour commercial kitchen grease duct applications per ASTM E 2336.
  - a. General Installation Instructions for Double Layer Installations: The inside and outside layers of FireMaster or Pyroscat blankets are cut to a length that will fit around the duct and meet with a tight butt joint. Adjacent blankets on the inside and outside layers are tightly butted against each other. Joints between blankets on the outside layer shall be offset from joints on the inside layer by a minimum 6 in. (152 mm). Cut edges of the blanket shall be taped with aluminum foil tape. During installation the blankets are temporarily held in place with filament tape until the wrap is mechanically attached with steel bands or steel insulation pins.
3. Install 1 layer of FireMaster FastWrap XL or Pyroscat Duct Wrap XL for 1 and 2 hour air ventilation duct enclosures per ISO 6944-1985.
  - a. General Installation Instructions for Single Layer Installations: FireMaster or Pyroscat blankets are cut to a length that will fit around the duct and overlap itself no less than 3 in. (152 mm). Adjacent blankets overlap each other a minimum of 3 in. (152 mm), or they can be fitted together with a tight butt joint and covered with a 6 in. (305 mm) wide collar centered over the butt joint. Cut edges of the blanket are taped with aluminum foil tape. During installation the blankets are temporarily held in place with filament tape until the wrap is mechanically attached with steel bands or steel insulation pins.
4. Install one layer of Thermal Ceramics PlenumWrap+ on plastic pipe or plastic jacketed electrical cables per Intertek listing reports and testing to NFPA 262 and UL1887.
  - a. Cut plenum blanket to a length that will fit around the pipe or cable and overlap itself no less than 1 in. (25 mm). Adjacent blankets overlap each other a minimum of 1 in. (25 mm). Plenum blanket is secured using either 1/2 in. (12 mm) steel banding or 16 gauge carbon or stainless steel tie wire on maximum 11-1/2 in. (292 mm) spacing.

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5. Mechanical Fastening of Enclosure Material to Ductwork:
    - a. Banding - Carbon steel or stainless steel banding is used to hold the outer layer of the blanket enclosure in place. Banding is minimum 1/2 in. (12.7 mm) wide, and is placed around the entire perimeter of the duct on maximum 10-1/2 in. (267 mm) centers and 1-1/2 in. (38 mm) from each blanket or collar edge.
    - b. Pinning - To prevent blanket sag on duct spans wider than 24 in. (610 mm), minimum 12-gauge steel insulation pins are welded to the duct along bottom horizontal and outside vertical runs in columns spaced 12 in. (305 mm) apart, 6 to 12 in. (152 to 305 mm) from each edge, and on 10-1/2 in. (267 mm) centers. Pins are locked in place with 1-1/2 in. (38 mm) diameter or 1-1/2 in. (38 mm) square galvanized steel speed clips or cup head pins. Pins are turned down or the excess cut off to eliminate sharp edges.
  6. Grease Duct Access Door Installation:
    - a. Install Thermal Ceramics FastDoor XL per manufacturers' instructions, and applicable building code reports and laboratory design listings.
  7. Through-Penetration Firestop System:
    - a. When the duct penetrates a concrete or dry wall fire rated floor, ceiling, or wall an approved firestop system shall be employed. FireMaster or Pyroscat insulation shall be installed directly to the duct through the penetration, or terminated on both sides of the penetration depending on the annular space allowance between the duct and the duct opening. When the FireMaster or Pyroscat enclosure system is terminated on both sides of the through penetration, the duct wrap material is mechanically attached to the duct at the termination points using either steel banding or steel pins.
    - b. To fire stop the through penetration void area, fill the annular space between the wrapped duct or bare duct and the periphery of the opening with scrap FireMaster or Pyroscat insulation firmly packed into the opening. Compress scrap blanket to percentage stated in the firestop listing for a minimum depth as specified in the firestop listing. Recess packing material below surface on both sides of walls or top side only for floors to the depth stated in the firestop listing. Seal over the packing material using an approved firestop sealant to a depth as stated in the firestop listing, flush with top side of a floor assembly and both sides of a wall assembly.

D. REPAIR PROCEDURES

1. Repair damaged FireMaster FastWrap XL or Pyroscat Duct Wrap XL in accordance with manufacturer's instructions.
2. Remove damaged section by cutting the bands and removing the anchor clips holding it in place. Apply a new section of the same dimension ensuring the same overlap and installation method that existed previously. Cut edges and tears in the foil must be taped with aluminum tape to prevent the insulation from wicking moisture or grease.

E. PROTECTION

1. Protect installed products until completion of project.



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2. Touch-up, repair or replace damaged products before Substantial Completion.

### 3.9 INSTALLATION OF HYDRONIC PIPING AND ACCESSORIES

- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and Drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and Drawing VS.1.
- B. Piping Installations:
  1. Locations and Arrangements: Drawings indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design consideration. So far as practical, install piping as indicated.
  2. Install piping at a uniform grade of 1 in. in 40 ft. upward in the direction of flow.
  3. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.
  4. Install branch connections to mains using Tee fittings in main with take-off out the bottom, except for up-freed risers which shall have take-off out the top of the main line.
  5. Install unions in pipes 2 in. and smaller, adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
  6. Install flanges on valves, apparatus, and equipment having 2-1/2 in. and larger connections.
  7. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, inline pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 in. and larger.
  8. Anchor piping to ensure proper direction of expansion and contraction. Expansion loops and joints are indicated on the Drawings.
  9. Install pipe sleeves at all wall and floor penetrations.
  10. Install escutcheons at all exposed pipe wall penetrations.
  11. Provide Dielectric couplings at all dissimilar piping/valve connections.
- C. Pipe Applications:
  1. Copper Tubing: Use Type L, drawn copper tubing with wrought copper fittings and solder joints for 2 in. and smaller, above ground, within building. Use Type K, annealed temper copper tubing for 2 in. and smaller without joints, below ground or within slabs. Mechanical fittings (crimp or flair) are not permitted.
  2. Steel Pipe: Use steel pipe with threaded joints and fittings for 2 in. and smaller, and with welded joints for 2-1/2 in. and larger.
  3. Steel Pipe: Use mechanical grooved end steel pipe and mechanical couplings and fittings.

- D. Grooved Pipe Ends and Fittings:
1. Roll Groove pipe ends in accordance with the latest published instructions from manufacturer of grooved couplings.
  2. Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. All grooved system components shall be of same manufacturer. Use grooved-end fittings and rigid or flexible, where required, grooved-end-pipe couplings. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
  3. Training
    - a. The grooved coupling manufacturer's (the "manufacturer") factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of groove joints products.
    - b. IACET/Training: A factory trained manufacturer's representative (direct employee) shall provide on-site training of contractor's field personnel in the use of grooving tools, application of groove, and product installation in compliance with the following:
      - 1) Manufacture must be accredited by the International Association for Continuing Education and Training (IACET).
      - 2) IACET Accredited Provider status demonstrates that the manufacture complies with the ANSI/IACET standard, which is recognized internationally as a standard of excellence in instructional practices.
  4. Inspection
    - a. A manufacture's factory trained representative shall periodically visit the job site and review the installation for best practices. The installing Contractor shall correct any identified deficiencies.
    - b. The grooved fittings manufacturer's product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by Inspection Services prior to the completion of the project. Any Victaulic product that has not been corrected or was not examined will not be considered as part of the successful completion of Inspection Services.
  5. Application
    - a. Upon completion of the manufacturer's inspection of the installation and any identified corrections, the manufacturer may provide the Owner or purchaser with a limited warranty on manufacturer's products.
- E. Valve Applications:
1. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
    - a. Shut-Off Duty: Use gate, and ball, valves.

- b. Throttling Duty: Use globe, ball, and plug valves.
  2. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
  3. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.
  4. Install safety relief valve on hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.
  5. Install pressure reducing valves on hot water generators, and elsewhere as required to regulate system pressure.
  6. Install isolation valves in all branch supply take-offs from piping mains which serve more than two terminal heating or cooling units. Provide balancing valve with positive shut off in all return branch take-offs which serve more than two terminal heating or cooling units. Provide isolation valves in floor supply main piping lines and balancing valves with positive shut-off in all floor return main piping take-offs.
- F. Hydronic Specialties Installation:
  1. Install automatic air vents at high points in the system, heat transfer coils, and elsewhere as required for system air venting. Install air vents with cocks such that vents can be removed without draining system.
  2. Install combination separator/strainer in pump suction lines. Run piping to compression tank with 1/4 in. per foot (two percent) upward slope towards tank. Install blowdown piping with gate valve; extend to nearest drain.
  3. Install pump suction diffusers on pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.
  4. Install shot-type chemical feeders in each hydronic system; in upright position with top of funnel not more than 48 in. above floor. Install feeder in bypass line, off main using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
  5. Install diaphragm-type compression tanks as indicated. Vent and purge air from hydronic system, charge tank with proper air charge to suit system design requirements.
    - a. In the absence of details provide support from the floor or structure above sufficient for the weight of water assuming a full tank of water. Do not overload building components and structural members.
- G. Field Quality Control:
  1. Preparation for Testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:
    - a. Leave joints including welds uninsulated and exposed for examination during the test.
    - b. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.

- c. Flush system with clean water. Clean strainers.
  - d. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
  - e. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
2. Testing: Test hydronic piping as follows:
- a. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
  - b. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at point for complete removal of the liquid.
  - c. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
  - d. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.
  - e. After the hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connection for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
- H. Adjusting and Cleaning:
- 1. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
  - 2. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.
- 3.10 INSTALLATION OF REFRIGERANT PIPING AND ACCESSORIES
- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and Drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and Drawing VS.1.

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- B. Piping Installations:
1. Locations and Arrangements: Drawings indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, and other design consideration. So far as practical, install piping as indicated.
  2. Install pipe sleeves at all wall and floor penetrations.
  3. Install escutcheons at all exposed pipe wall penetrations.

### 3.11 INSTALLATION OF CONDENSING BOILERS

- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and Drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and Drawing VS.1.
- B. General: Install boilers in accordance with manufacturer's installation instructions, in accordance with State and Local Code requirements. Install units plumb and level, to tolerance of 1/8 in. in 10 ft. – 0 in. in both directions. Maintain manufacturer's recommended clearances around and over boilers.
- C. Support: Install boilers on 4 in. thick concrete pad, 4 in. larger on each side than base of unit. Provide supplemental structural steel supports (minimum 8 in. high) to elevate boiler as required to allow proper condensate drainage.
- D. Electrical Work: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
1. Verify that electrical work installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until electrical work is acceptable to equipment Installer.
- E. Gas Piping: Connect gas piping to boiler, full size of boiler gas train inlet, provide union with sufficient clearance for burner removal and service.
- F. Hot Water Piping: Connect supply and return boiler tappings as indicated, with shutoff valve and union or flange at each connection.
- G. Regulator Vents: Provide 3/4 in. vent from each main and pilot regulator. Each vent shall terminate outdoors per code requirements.
- H. Breeching: Connect breeching to boiler outlet, full size of outlet. Route as indicated. Coordinate breeching routing and sizing with Boiler Manufacturer and vent system manufacturer.
- I. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.
- J. Hydrostatically test assembled boiler and piping in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.

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- K. Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boiler piping, observation of hydrostatic testing, and for certification of completed boiler units.
  - L. Start-up boilers, in accordance with manufacturer's start-up instructions, and in presence of boiler manufacturer's start up representative. Test controls, and demonstrate compliance with requirements. Adjust burner for maximum burning efficiency. Replace damaged or malfunctioning controls and equipment.
  - M. Owner's Instructions: Provide services of manufacturer's technical representative for 4-hour day to instruct Owner's personnel in operation and maintenance of boilers.
    - 1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.
  - N. Boiler Installation
    - 1. Install boilers level on concrete base.
    - 2. Install gas-fired boilers according to NFPA 54.
    - 3. Assemble and install boiler trim.
    - 4. Install electrical devices furnished with boiler but not specified to be factory mounted.
    - 5. Install control wiring to field-mounted electrical devices.
  - O. Connections
    - 1. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
    - 2. All external hydraulic connections shall be able to be connected in any configuration on either the left or right side of the Boiler(s) in order to allow for maximum installation flexibility and site requirements.
    - 3. Install piping adjacent to boiler to allow service and maintenance.
    - 4. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
    - 5. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
    - 6. Connect hot-water piping to supply- and return-boiler connections with shutoff valve and union or flange at each connection.
    - 7. Install piping from safety relief valves to nearest floor drain.
    - 8. Boiler Venting:
      - a. Install flue venting per manufacturer's requirements and Plumbing Division 22 requirements.
      - b. Connect full size to boiler connections. Comply with requirements in Division 22 Section "Breechings, Chimneys, and Stacks."
    - 9. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
    - 10. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

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- P. Field Quality Control
1. Perform tests and inspections and prepare test reports.
    - a. Manufacturer's Field Service: Engage a factory-authorized service representative or technician to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
  2. Tests and Inspections:
    - a. Perform installation and startup checks according to manufacturer's written instructions.
    - b. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
    - c. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
    - d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      - 1) Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
      - 2) Set field-adjustable switches and circuit-breaker trip ranges as indicated.
  3. Remove and replace malfunctioning units and retest as specified above.
- Q. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01 Section "Demonstration and Training."

### 3.12 INSTALLATION OF HVAC PUMPS

- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and Drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and Drawing VS.1.
- B. General: Install HVAC pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized practices to ensure that HVAC pumps comply with requirements and serve intended purposes.
- C. Access: Provide access space around HVAC pumps for service as indicated, but in no case less than that recommended by manufacturer.
- D. Support: Install base-mounted pump assembly on minimum of four in. high concrete base equal or greater than three times total weight of pump and motor. Set and level pump in base and grout with non-shrink grout.
- E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

F. Adjusting and Cleaning

1. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
2. Start-Up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
3. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.13 INSTALLATION OF AIR COOLED CHILLER

A. Vibration Control, refer to section 230548 and drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control manufacturer shall recommend the correct connection and device as outlined in section 230923 and drawing VS.1.

B. GENERAL:

1. Verify all dimensions by field measurements. Verify structure, mounting supports, and membrane installations are completed to the proper point to allow installation of units. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation. Do not proceed until unsatisfactory conditions have been corrected.
2. Install chiller in accordance with manufacturers installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

C. FIELD QUALITY CONTROL:

1. Provide the services, to include a written report, of a factory authorized service representative to examine the field assembly of the components, installation, and piping and electrical connections. Submit start-up report to engineer for review.

D. DEMONSTRATION:

1. Provide the services of a factory authorized service representative to provide start-up service and to demonstrate and train the Owner's maintenance personnel as specified below.
2. Start-up service: Place units into operation and adjust controls and safeties. Replace damaged or malfunctioning components and controls.

E. TRAINING:

1. Train the Owner's maintenance personnel on start-up and shut-down procedures, troubleshooting procedures, and servicing and preventative maintenance schedules and procedures. Provide a minimum of 8 hours of training.
2. Schedule training with Owner through the Architect/Engineer with at least 7 days prior notice. Video record training session. Submit media to Owner upon completion of training.



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3.14 INSTALLATION OF HVAC ROOFTOP UNITS (RTU)

- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and Drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and Drawing VS.1.
- B. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.
- C. Support: Contractor shall coordinate installation with the roofing contractor, and shall install and secure roof curb to roof structure, per details on the drawings and in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.
- D. Access: Provide access space around air handling units for service as indicated, but in no case less than that recommended by manufacturer.
- E. Duct Connections: Provide ductwork, accessories, and flexible connections as indicated.
- F. Grounding: Provide positive equipment ground for air-handling unit components.
- G. Provide a complete set of filters, (pre-final-erw) for each roof top unit and install at the completion of air handling system work and prior to unit operation. Provide another complete set of filters prior to the LEED flushout requirements. After the projects substantial completion and flush out requirements are complete, site work will begin and create an increased amount of dust. During this time frame of one year, provide the owner with four complete sets of filters for each rooftop unit as attic stock, these filters will be installed by the owner. Provide receipt from Owner that new filters have been installed and additional extra attic stock filters have been provided.
- H. Provide one spare set of belts for each belt-driven air handling unit, obtain receipt from Owner that belts have been received.
- I. Electrical Connections: Refer to electrical sections for final connections to equipment and installation of loose shipped electrical components.
- J. Start-Up Services:
  - 1. Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

- K. Operating and Maintenance Training:
  - 1. Provide services of manufacturer's service representative (minimum 8 hrs.) to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and trouble-shooting procedures plus procedures for obtaining repair parts and technical assistance.
  - 2. Schedule training with Owner, provide at least 7-day prior notice to the Architect/Engineer.

### 3.15 INSTALLATION OF ROOFTOP AIR HANDLING UNITS

- A. Vibration Control And Seismic Restraint: Refer to section 23 05 48 and drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 23 05 48 and drawing VS.1.
- B. General: Install heat exchanger units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.
- C. Coordination: Coordinate with other work, including ductwork, floor construction, roof decking, and piping, as necessary to interface installation of air-handling units with other work.
- D. Access: Provide access space around air handling units for service as indicated, but in no case less than that recommended by manufacturer.
- E. Support: Install floor-mounted air handling units with 4" high reinforced concrete pad, 4" larger on each side than unit base.
- F. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 260010 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.
- G. Duct Connections: Provide ductwork, accessories, and flexible connections as indicated.
- H. Grounding: Provide positive equipment ground for air-handling unit components.
- I. Testing: Upon completion of installation of air-handling units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, than retest to demonstrate compliance.

- J. Provide a complete set of filters, (pre-final-erw) for each heat exchanger unit and install at the completion of air handling system work and prior to unit operation. Provide another complete set of filters prior to the LEED flushout requirements. After the projects substantial completion and flush out requirements are complete, site work will begin and create an increased amount of dust. During this time frame of one year, provide the owner with four complete sets of filters for each unit as attic stock, these filters will be installed by the owner. Provide receipt from Owner that new filters have been installed and additional extra attic stock filters have been provided.
- K. Provide one spare set of belts for each belt-driven air handling unit, obtain receipt from Owner that belts have been received. Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- L. Operating and Maintenance Training:
  - 1. Provide services of manufacturer's service representative (4 hours minimum) to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and trouble-shooting procedures plus procedures for obtaining repair parts and technical assistance.
  - 2. Schedule training with Owner, provide at least 7-day prior notice to the Architect/Engineer.

### 3.16 INSTALLATION OF TERMINAL HEATING UNITS (HYDRONIC)

- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and Drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and Drawing VS.1.
- B. Installation of Finned Tube Radiation: (Hydronic)
  - 1. General: Install finned tube radiation as indicated, and in accordance with manufacturer's installation instructions.
  - 2. Locate finned tube radiation as indicated, run cover wall-to-wall unless otherwise indicated. Provide butt caps, splice joints, and "Z" bends for a complete installation.
  - 3. Install access panels centered in front of each shutoff valve, balancing cock, steam trap, or temperature control valve.
- C. Installation of Convectors: (Hydronic)
  - 1. General: Install convectors as indicated, and in accordance with manufacturer's installation instructions.
  - 2. Locate convectors as indicated, coordinate with other trades to assure correct recess size for recessed convectors.

- D. Installation of Horizontal Unit Heaters: (Hydronic)
1. General: Install unit heaters as indicated, and in accordance with manufacturer's installation instructions.
  2. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.
  3. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated.
  4. Support units with rod-type hangers anchored to building substrate.
  5. Install piping as indicated.
  6. Protect units with protective covers during balance of construction.
- E. Installation of Cabinet Unit Heaters: (Hydronic)
1. General: Install cabinet heaters as indicated, and in accordance with manufacturer's installation instructions.
  2. Coordinate with other trades to assure correct recess size for recessed units.
  3. Install piping as indicated.
  4. Protect units with protective covers during balance of construction.
- F. Installation of Coils: (Hydronic)
1. General: Install coils as indicated, and in accordance with manufacturer's installation instructions.
  2. Pitch coil casings for drainage, not less than 1/8 in. toward return connections, except where drainage feature is included in coil design.
- G. Installation of Radiant Panels
1. Install radiant panel level and plumb. Maintain sufficient clearance for normal services, maintenance, or in accordance with construction drawings.
  2. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
    - a. Verify that controls and control enclosure are accessible.
    - b. Verify that control connections are complete to control valves as needed.
    - c. Verify that any identification tags are visible.
    - d. Verify that controls respond to inputs as specified.
  3. Connections
    - a. Piping installation requirements are specified in other Division 23 Sections. Drawings indicated general arrangement of piping, fittings, and specialties.
    - b. Install piping adjacent to radiant panels to allow for service and maintenance.
    - c. In addition to Division 23 Section "Hydronic Piping", connect copper tubing to supply with shut-off valve, strainer, control valve, and union or flange, and return pipe with balancing valve and union or flange.
    - d. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

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- e. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening.
  - 4. Field Quality Control
    - a. Perform the following field tests and inspections and prepare test reports:
      - 1) Leak Test: After installation, fill water tubes and test for leaks. Repair leaks and retest until no leaks exist.
      - 2) Operational Test: After electrical circuitry has been energized, start units to conform to proper unit operation.
      - 3) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - b. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field assembled components and equipment installation, including connections, and to assist in field testing. Report any findings in writing.
    - c. Remove and replace malfunctioning units and retest as specified above.
  - 5. Cleaning and Protection
    - a. Clean all visible surfaces of equipment; touch up as required.
    - b. Protect all units before, during and after installation. Damaged materials due to improper protection shall be cause for rejection.
  - 6. Construction Phase Services
    - a. Manufacturer or factory-authorized representative shall visit the site regularly during the installation process to ensure proper means and methods are being employed. Bid shall include the cost of a minimum of two (2) such visits.
    - b. Manufacturer or factory-authorized representative shall provide start-up and training services to owners/staff to adjust, operate, and maintain radiant panels.
  - H. Adjusting and Cleaning:
    - 1. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.
    - 2. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
    - 3. Install new filter units for terminals requiring same.
    - 4. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
      - a. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
  - I. Provide spare filters for each cabinet unit heater. Provide enough filters to do 3 complete filter change outs at each cabinet unit heater. Obtain receipt from Owner that stock of spare filters has been received.

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3.17 INSTALLATION OF TERMINAL HEATING UNITS (ELECTRIC)

- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and Drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and Drawing VS.1.
- B. Installation of Electric Heating Terminals:
1. Install electric heating terminal units including components as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices; complying with applicable installation requirements of NEC and NECA's "Standard of Installation".
  2. Coordinate with other electrical work, including wiring/cabling, as necessary to properly interface installation of heating terminal units with other work.
  3. Clean dust and debris from each heating terminal as it is installed to ensure cleanliness.
  4. Comb out damaged fins where bent or crushed before covering elements with enclosures.
  5. Touch-up scratched or marred heating terminal enclosure surfaces to match original finishes.
  6. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminal to comply with tightening torques specified in UL Std. 486A.
- C. Grounding:
1. Provide equipment grounding connections for electric heating terminals as indicated, Tighten connections to comply with tightening torque values specified in UL std. 486A to assure permanent and effective grounding.
- D. Electrical Wiring:
1. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electric Installer.
    - a. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
    - b. Upon completion of installation of electric heating terminals, and after building circuitry has been energized, test heating terminals to demonstrate capability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
    - c. Replace electric heating terminals and accessories which are damaged and remove damaged items from construction site.

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- E. Adjusting and Cleaning:
    - 1. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.
    - 2. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
    - 3. Install new filter units for terminals requiring same.

### 3.18 INSTALLATION OF POWER AND GRAVITY VENTILATORS

- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and Drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and Drawing VS.1.
- B. General: Except as otherwise indicated or specified, install ventilators in accordance with manufacturer's installation instructions and recognized industry practices to insure that products serve the intended function.
- C. Coordinate ventilator work with work of roofing, walls and ceilings, as necessary for proper interfacing.
- D. Ductwork: Connect ducts to ventilators in accordance with manufacturer's installation instruction, and details on drawings.
- E. Roof Curbs: Furnish roof curbs to roofing Installer for installation.
- F. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Verify proper rotation direction of fan wheels. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- G. Remove shipping bolts and temporary supports within ventilators. Adjust dampers for free operation.
- H. Testing: After installation of ventilators has been completed, test each ventilator to possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.
- I. Cleaning: Clean factory-finished surface. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- J. General: Furnish to Owner, with receipt, one spare set of belts for each belt driven power ventilator.

### 3.19 INSTALLATION OF METAL DUCTWORK

#### A. Installation of Metal Ductwork:

1. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight (five percent leakage for systems rated 3 in. and under; one percent for systems rated over 3 in.) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately with internal surface smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.
2. Sealing: All ductwork joints and seams shall be sealed with flexible duct sealer to assure an airtight installation.
3. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2 in. Fasten to duct and substrate.
  - a. Where ducts pass through fire-rated floors, walls, or partitions, provide firestopping between duct and substrate.
4. Coordination: Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
5. Installation: Install metal ductwork in accordance with "SMACNA HVAC Duct Construction Standards".

#### B. Installation of Duct Liners:

1. General Install duct liners in accordance with SMACNA "HVAC Duct Construction Standards".

#### C. Installation of Flexible Ducts:

1. Maximum Length: For any duct run using flexible ductwork, do not exceed 4 ft.-0 in. extended length.
2. Installation: Install in accordance with Section II of SMACNA's, "HVAC Duct Construction Standards, Metal and Flexible".

#### D. Field Quality Control:

1. Leakage Tests: After each duct system that is constructed test for duct leakage in accordance with SMACNA "HVAC Air Duct Leakage Test Manual". Repair leaks and repeat tests until SMACNA requirements are achieved.

#### E. Equipment Connections:

1. General: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery.



- F. Adjusting and Cleaning:
  - 1. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
  - 2. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until final connections are to be completed.
  - 3. Balancing: Refer to Division 23 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork. Seal any leaks in ductwork that become apparent in balancing process.
- G. Construction IAQ Management:
  - 1. Follow the SMACNA guidelines for "Duct Cleanliness for New Construction Guidelines" according to advanced levels of cleanliness. Including but not limited to:
    - a. Specify that ductwork be sealed when transported to the construction site
    - b. Store ductwork in clean, dry conditions and keep sealed while it is stored.
    - c. Wipe down internal surfaces of ductwork immediately prior to installation to remove dust.
    - d. Seal open ends on completed ductwork and overnight work-in-progress.
    - e. During installation, protect ductwork waiting to be installed with surface wrapping.
    - f. During construction, seal HVAC supply and return openings to protect them from dust infiltration.

### 3.20 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install turning vanes in square or rectangular 90 degree elbows in supply, return, and exhaust air systems, and elsewhere as indicated.
- C. Install volume and/or splitter damper with adjusting rod in each supply branch. Install according to detail on drawings.
- D. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- E. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

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- F. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
  - G. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
  - H. Furnish extra fusible links to owner, one link for every 10 installed of each temperature range; obtain receipt.

### 3.21 INSTALLATION OF FABRIC DUCT

#### A. INSTALLATION OF TEXTILE AIR DISPERSION SYSTEM:

1. Install chosen suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.

#### B. CLEANING AND PROTECTION:

1. Clean air handling unit and ductwork prior to the DuctSox system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.
2. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.
3. If DuctSox systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

### 3.22 INSTALLATION OF ACOUSTIC DUCT LINING

- A. Installation: All portions of duct designed to receive duct liner shall be completely covered. The smooth, black coated surfaces shall face the airstream. All liners shall be cut to assure tight, overlapped corner joints. The top pieces shall be supported by the side pieces. The liner shall be adhered to the sheet metal with full coverage of an approved adhesive that conforms to ASTM C 916, and all exposed leading edges and transverse joints shall be coated with Permacote factory-applied or field-applied edge coating and shall be neatly butted without gaps. Shop or field cuts shall be liberally coated with "Schuller SuperSeal Edge Treatment" or approved adhesive. The liner shall be additionally secured with mechanical fasteners. The pin length should be such as to hold the material firmly in place with minimum compression of the material.

### 3.23 INSTALLATION OF SOUND ATTENUATORS

- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and Drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS.1.
- B. General: Install sound attenuators as indicated, and in accordance with manufacturer's installation instructions.

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- C. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.
  - D. Upon completion of installation test and demonstrate that sound attenuators, and duct connections to sound attenuators, are leak tight.

### 3.24 INSTALLATION OF AIR OUTLETS AND INLETS

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended function.
- B. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.
  - 1. INSTALLATION OF INDUCTION TERMINAL UNIT (ACTIVE CHILLED BEAMS)
    - a. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS.1.
    - b. General: Install induction terminal unit as indicated, and in accordance with manufacturer's installation instructions.
    - c. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.

### 3.25 INSTALLATION OF VARIABLE AIR VOLUME BOX (VAV)

- A. VIBRATION CONTROL AND SEISMIC RESTRAINT: Refer to section 23 05 48 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 23 05 48 and drawing VS-1.
- B. General: Install variable air volume boxes as indicated, and in accordance with manufacturer's installation instructions.
- C. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.
- D. Install all transformers within junction boxes and maintain three foot clearance in front per the electrical code. This will allow the VAV control box to only utilize low voltage wiring and not be susceptible to the three foot clearance requirement by the electrical code.

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3.26 INSTALLATION OF CONSTANT VOLUME DAMPERS

- A. General: Install variable air volume boxes as shown on drawings, and in accordance with manufacturer's installation instructions. Utilize recognized industry practices to ensure that products serve intended function.
- B. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for future adjustments, but in no case less than that recommended by manufacturer.

3.27 INSTALLATION OF DUCTLESS COOLING UNIT SYSTEMS

- A. Vibration Control And Seismic Restraint: Refer to SECTION 230548 and Drawing VS.1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and Drawing VS.1.
- B. General:
  - 1. Verify all dimensions by field measurements. Verify roof structure, mounting supports, wall structure, and membrane installations are completed to the proper point to allow installation of wall mounted and roof mounted units. Examine rough-in for refrigerant piping systems to verify actual locations of piping connections prior to installation. Do not proceed until unsatisfactory conditions have been corrected.
  - 2. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- C. Field Quality Control:
  - 1. Provide the services, to include a written report, of a factory authorized service representative to examine the field assembly of the components, installation, and piping and electrical connections.
  - 2. Charge systems with refrigerant and oil, and test for leaks. Repair leaks and replace lost refrigerant and oil.
- D. Demonstration:
  - 1. Provide the services of a factory authorized service representative to provide start-up service and to demonstrate and train the Owner's maintenance personnel as specified below.
  - 2. Start-up service: Place units into operation and adjust controls and safeties. Replace damaged or malfunctioning components and controls.
- E. Training:
  - 1. Provide the services of manufacturer's service representative (two hours minimum) to instruct the Owner's maintenance personnel on start-up and shut-down procedures, troubleshooting procedures, controller features, and servicing and preventative maintenance schedules and procedures.
  - 2. Schedule training with Owner through the Architect/Engineer with at least seven days prior notice.

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### 3.28 INSTALLATION OF CONDENSATE DISCHARGE PUMPS

- A. Examine areas and conditions under which pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.
- B. Installation Of Equipment
  - 1. General: Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in drain pans and locations indicated, and maintain manufacturer's recommended clearances.
  - 2. Accessories: Install equipment accessories not installed at factory.
  - 3. Connections: Connect discharge piping as indicated and terminate where indicated on the contract documents.
  - 4. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.
    - a. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- C. Field Quality Control
  - 1. General: Start-up equipment, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- D. Closeout Procedures
  - 1. Training: Instruct Owner's personnel in operation and maintenance of condensate discharge pumps.

### 3.29 INSTALLATION OF FIRESTOP SYSTEMS

- A. General: Install firestop systems at all fire-rated and smoke rated construction where penetrated by the Work of this Section.
- B. Refer to Section 078400 - FIRESTOPPING, for all installation requirements for maintaining integrity of fire-rated and smoke rated construction at penetrations.

### 3.30 INSTALLATION OF WALL AND CEILING ACCESS DOORS

- A. General: Install access doors in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended function.
- B. All access doors shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that the item or part can be easily reached, and the size shall be sufficient for this purpose (minimum size 12 in. X 16in.). Furnish access doors to permit thorough inspection. When access doors are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.

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### 3.31 INSTALLATION OF WATER TREATMENT

#### A. INSPECTION

1. General: Examine areas and conditions under which treatment systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer. Refer to water treatment section for requirements and further information.

#### B. INSTALLATION OF WATER TREATMENT SYSTEM

1. General: Install water treatment system in accordance with manufacturer's written instructions.
2. Coordinate with other work as necessary to interface components of water treatment system properly with condenser cooling water.
3. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - a. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
4. Install pressure gages, valves, and controls furnished by manufacturer, in accordance with manufacturer's instructions.

#### C. START-UP

1. Start-up Procedures: During heating and cooling water system start-up, operate heating and cooling water treatment system after charging with specified chemicals to maintain required steady-state characteristics of heating and cooling water.

### 3.32 AUTOMATIC TEMPERATURE CONTROLS (DDC)

#### A. Installation Of Automatic Temperature Controls (DDC):

1. Installation of Control Systems:
  - a. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
  - b. Control Wiring: Install control wiring, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code.
    - 1) Install circuits over 25-volt with color-coded No. 12 wire in electric metallic tubing.
    - 2) Install circuits under 25-volt with color-code No. 18 wire with 0.031 in. high temperature 105 degrees F. (41 degrees C) plastic insulation on each conductor and plastic sheath over all.
    - 3) Install electronic circuits with color-coded No. 22 wire with 0.023 in. polyethylene insulation on each conductor with plastic-jacketed copper shield over all.

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- 4) Install low voltage circuits, located in concrete slabs, masonry walls, or in mechanical areas, in electrical conduit. Where exposed in occupied areas install all wiring in wiremold.
  - 5) Power sources from lighting circuits and wall outlets shall not be used to power DDC controllers.
  - c. Controllers and safety devices:
    - 1) All safety devices such as freezestats, duct mounted heat detectors, and smoke detectors shall be hard wired to shut down the fans independently. Provide audible alarm with silence switch as well as DDC indication.
    - 2) All supply, return and exhaust fans shall be provided with pressure differential switches. Current sensing devices, starter auxiliary contacts, and relay contacts are unacceptable proof of fan operation.
    - 3) Primary and standby pumps shall be selectable through the DDC control system. Provide local pilot light to indicate selected pump as well as alarm and silence switch for failed pump. Provide differential pressure switch to prove flow.
  2. Adjusting and Cleaning:
    - a. Start-Up: Start-up, test, and adjust DDC control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
    - b. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
    - c. Final Adjustment: After completion of installation, adjust thermostats, control valves, motor and similar equipment provided as work of this section.
      - 1) Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.
  3. Closeout Procedures:
    - a. Owner's Instructions: Provide services of manufacturer's technical representative for 40 hours of onsite instruction training on running and basic troubleshooting of DDC control system.
    - b. Validation: The automatic temperature control contractor shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the approved specifications and sequence of operation submitted.
      - 1) Witnessed validation demonstration shall consist of:
        - a) Execute digital and analog commands in English and graphic mode.
        - b) Demonstrate all specified diagnostics.
        - c) Demonstrate scan, update, and alarm responsiveness.
      - 2) Comply with SECTION 019113 and 230800 – COMMISSIONING REQUIREMENTS.

c. Training:

- 1) All training shall be by the automatic temperature control contractor and shall utilize specified manuals and as-built documentation.
- 2) Operator training shall include:
  - a) Sequence of Operation review.
  - b) Sign on-Sign off.
  - c) Modifying warning limits, alarm limits and start-stop times.
  - d) System initialization.
  - e) Use of Portable Operators Terminal.
  - f) Troubleshooting of sensors (determining bad sensors).
  - g) Point disable/enable.
  - h) Software review of Sequence of Operation programs.
  - i) Modification of control programs.
  - j) Add/Delete/Modify data points.
  - k) Use of diagnostics.
  - l) Review of initialization.
- 3) Training shall be for Owner-designated personnel at the subject site, and shall be scheduled by the Owner with two week notice.
- 4) All training sessions shall be videotaped by professional videographer, refer to architectural specifications for further requirements.

d. Seasonal Site Visits:

In addition to the one year warranty period against component or workmanship defects, 40 hours of training and 40 hours of extra programming as it relates to the control system and as indicated in section 23 00 00 paragraph 2.30 & 3.32, the ATC contractor shall provide a seasonal site visit to confirm, verify and modify as required the sequence and/or programming of each piece of equipment to ensure the system is functioning as required and per the sequence of operations. The ATC contractor shall provide 16 labor hours per season (four times within a year, total of 64 hours). During each visit they shall, for each piece of equipment confirm operation and functionality, modify and/or repair any control related issues and/or programming and provide training as requested by the owner. This requirement will ensure the equipment/building is operating properly and efficiently as it cycles through each season. These site visits shall begin the following season after substantial completion of the project is issued. Upon substantial completion the ATC Contractor shall issue four dates to the Engineer of Record and Owner. Signatures and time logs will be kept by both parties to ensure these visits occur.

- e. Perform Indoor Air Quality Management Building flush out procedures and adhere to IAQ Management Procedures referenced in Section 018119 – INDOOR AIR QUALITY REQUIREMENTS.



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### 3.33 TESTING, ADJUSTING, AND BALANCING

#### A. REQUIREMENTS:

1. Requirements include verification of HVAC system operation, measurement of all system capacity, and establishment of the quantities of the mechanical systems as required to meet specifications, and recording and reporting the results.
2. The entire project is considered phased construction, and as such, as each phase of construction is completed the appropriate balancing for that phase of work shall be completed. At the completion of all phases of construction each previous phase of completed balancing must be re-checked and re-adjusted accordingly to match final design conditions. A preliminary report of each phase of construction will be submitted for approval during each phase of construction, and a final balancing report including all phases of construction will be submitted at the completion of the project.
3. Commission, test, adjust and balance the following mechanical systems:
  - a. Supply air systems.
  - b. Return air systems.
  - c. Exhaust air systems.
  - d. Outside air systems.
  - e. Hydronic heating hot water, dual temp water, condenser water, Cogen hot water and chilled water systems.
  - f. Verify temperature control system operation.
4. Do not include:
  - a. Testing boilers and pressure vessels for compliance with safety code.
  - b. Installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing. Contact Mechanical Contractor and the Engineer for direction.
5. Comply with Commissioning Test Requirements in Section 019113 and 230800.
6. Comply with Indoor Air Quality Management Building flush out procedures and adhere to IAQ Management Procedures referenced in SECTION 018119 – INDOOR AIR QUALITY REQUIREMENTS.
  - a. All rooftop units shall operate at the maximum amount of outside air (the design outside airflow rate for maximum occupancy as indicated on the mechanical schedules) during and after the installation of VOC emitting materials for the maximum amount of time feasible, but not less than continuously (i.e. 24 hours) for seven days. During this time, the design temperature and humidity set points shall be maintained. The installation of VOC emitting materials shall be fully coordinated with the Architect.

- b. If the project has fallen behind schedule and cannot run the equipment for the required period of time (24 hours for seven days), the flush-out can alternatively be performed while the building is occupied provided all of the following measures to protect building occupants are taken prior to their use of the space: percent
  - 1) All of the rooms in the school must be inspected for health and thermal comfort by a trained technician or a certified Industrial Hygienist before occupancy. The occupancy evaluation report must be reviewed and approved by a certified Industrial Hygienist (i.e. certified by the American Council of Government and Industrial Hygienists (ACGIH) shall be submitted to LEED showing the following elements have been met at a minimum:
    - a) Each classroom has been tested to show that the ventilation rate meets minimum code required ventilation rate and receives continuous ventilation during occupancy, per Title 8, Sec 5142.
    - b) The HVAC filters on all HVAC units are properly in place and meet the MERV rating as specified for the project, the HVAC condensate pans drain correctly and internal HVAC insulation undamaged.
    - c) Each classroom has been tested to show that particulate matter, PM 10, has measured to be 20 micrograms per cubic meter or less than the outdoor air levels and the PM 2.5 12 micrograms per cubic meter or less than outdoor air levels.
    - d) Each classroom has been tested to show that the carbon monoxide has been measured and is less than 9 parts per million but not greater than 2 ppm above outdoor levels. Each classroom has been tested to show that the carbon dioxide has been measured and is less than 200 ppm above outdoor CO<sub>2</sub> levels nearby. The room must be unoccupied during testing, and testing should occur during at least on rush-hour period.
    - e) Each classroom has been tested to show that the temperature and relative humidity have been measured and are within the criteria in the current ASHRAE Standard 55.
  - 2) Each classroom has been inspected and observed to ensure that there are no health or safety concerns from any chemical, moisture and odor sources in or near the classrooms.
    - a) Conduct the flush-out for 24 hours a day of continuous ventilation for a total of days necessary for all supply fans at their maximum rate and position. Thermal comfort is maintained during occupied hours, per the criteria in the current ASHRAE Standard 55. Internal temperatures are maintained at the most energy efficient level above 60 deg. F; relative humidity is maintained no higher than 60 percent during non-occupancy hours. Under conditions where the heating can't be met (60 deg. F) at that fan speed, then adjust the fan to meet the 60 deg. F.

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- b) All air handling unit dampers are at their maximum outdoor air position during the 14 day flush-out
  - 3) Post-occupancy ventilation: When the contractor is required to perform touch-up (including furniture after occupancy) work involving products with chemical emissions, provide temporary construction ventilation during application and extend the building flush-out by a minimum of four days after touch-up application, with 100 percent tempered outside air for 24 hours each day.
  - c. All unit filters to be replaced upon completion of flush-out
- B. Report:
- 1. Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
    - a. General Information and Summary.
    - b. Air Systems.
    - c. Hydronic heating, dual temp and cooling systems.
    - d. Temperature Control Systems.
  - 2. Contents: Provide the following minimum information, forms and data:
    - a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal and name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentation used for the procedures along with the proof of calibration.
    - b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC for each respective item and system.
    - c. Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.
- C. QUALITY ASSURANCE:
- 1. An independent testing, adjusting, and balancing agency certified by the AABC or NEBB as a Test and Balance Engineer in those testing and balancing disciplines required for this project.
  - 2. Codes and Standards:
    - a. AABC: "National Standards For Total System Balance".
    - b. ASHRAE: ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.

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3. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Architect/Engineer and Mechanical Contractor. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.
  4. System Operation: Systems shall be fully operational prior to beginning procedures. All new automatic temperature controls shall be fully operational. Test, adjust and balance the air systems before refrigerant systems. Test, adjust and balance air conditioning systems during summer season, and heating systems during winter season, including at least a period of operation at outside conditions within 5E F. wet bulb temperature of maximum summer design condition, and within 10E F. dry bulb temperature of minimum winter design condition. Take final temperature reading during seasonal operation.
  5. Test all fume hoods in accordance with ANSI/ASHRAE 110 Standards. Balancer shall record and report all data and adjust fan sheaves, dampers etc. as required to achieve desired velocities and air flows.

D. PRELIMINARY PROCEDURES:

1. Air Systems:
  - a. Obtain drawings and become thoroughly acquainted with the systems.
  - b. Compare drawings to installed equipment and field installations.
  - c. Walk the system from the system air handling equipment to terminal units to determine variations in installation.
  - d. Check filters for cleanliness.
  - e. Check all dampers (volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
  - f. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross check with required fan volumes.
  - g. Determine best locations in main and branch ductwork for most accurate duct traverses. Traverses shall be performed in each supply and return duct main and sub-mains for each AHU and return air fan.
  - h. Place outlet dampers in the full open position.
  - i. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
  - j. Verify lubrication of all motors and bearings.
  - k. Check fan belt tension.
  - l. Check fan rotation.
2. Hydronic Systems:
  - a. Open valves to full open position. Close coil bypass valves.
  - b. Remove and clean all strainers.
  - c. Examine hydronic systems and determine if water has been treated and cleaned.
  - d. Check pump rotation.

- e. Check expansion tanks to verify noted air pressure and that the system is completely full of water.
  - f. Check air vents at high points of system and determine if all are installed and operating freely.
  - g. Set temperature controls so all coils are calling for full flow.
  - h. Check operation of automatic bypass valves.
  - i. Check and set operating temperatures of chillers, boilers, and heat exchangers to design requirements.
  - j. Verify lubrication of all motors and bearings.
3. Measurements:
- a. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerance specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
  - b. Provide instruments meeting the specifications of the referenced standards.
  - c. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
  - d. Apply instrument as recommended by the manufacturer.
  - e. Use instruments with minimum scale and maximum subdivisions and with scaled ranges proper for the value being measured.
  - f. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
  - g. Take all reading with the eye at the level of the indicated value to prevent parallax.
  - h. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
  - i. Take measurements in the system where best suited to the task.

E. Performing Testing, Adjusting, and Balancing:

- 1. Test, adjust and balance all noted systems according to SMACNA standards and as follows:
  - a. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
  - b. Cut insulation and ductwork for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
  - c. Patch insulation, ductwork, and housings, using materials identical to those removed.
  - d. Seal ducts and test for and repair leaks.
  - e. Seal insulation to re-establish integrity of the vapor barrier.

- f. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
  - g. Retest, adjust and balance system subsequent to significant system modifications, and resubmit test results.
2. System Deficiencies:
- a. The Balancing Contractor shall advise the Mechanical Contractor and the Engineer of all system deficiencies in writing. Report all motors not running, missing dampers, inoperative valves and controls, or lack of access.
  - b. Upon completion of system deficiencies, Balancing Contractor shall balance and record data. Again at no additional cost to the Project/Owner.
  - c. Any re-balancing required to meet the desired CFM or modified CFM due to system modifications or owner changes shall be provided at no additional costs to the Project/Owner.
  - d. The balancing sub-subcontractor shall provide the necessary sheave and belt changes/modifications to motors/fans as required to achieve the desired CFM at no additional costs to the Project/Owner.

End of Section

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VIBRATION CONTROL AND SEISMIC RESTRAINT

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Section 23 05 48  
VIBRATION CONTROL AND SEISMIC RESTRAINT

**PART 1 - GENERAL**

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this section of the Specifications.
- B. Examine all other sections of the specifications for requirements that affect work of this section whether or not such work is specifically mentioned in this section.
- C. Coordinate work with that of all other trades affecting or affected by work of this section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 DESCRIPTION OF WORK

- A. General: The work noted within Section 23 05 48 is referenced by Divisions 21 00 00, 22 00 00, 23 00 00 and 26 00 00. Provide all necessary labor & material in each division as required herein.
- B. Intent:
  - 1. All mechanical, plumbing, fire protection & electrical equipment, piping, conduits and ductwork shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
  - 2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
  - 3. It is the intent of the seismic portion of this specification to keep all mechanical, plumbing, fire protection and electrical building system components in place during a seismic event.
  - 4. All such systems must be installed in strict accordance with seismic codes, component manufacturer's, and building construction standards. Whenever a conflict occurs between the manufacturer's or construction standards, the most stringent shall apply.
  - 5. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements).
  - 6. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

- C. The work in this section includes, but is not limited to the following:
1. Vibration isolation for piping, conduits, ductwork and equipment.
  2. Equipment isolation bases.
  3. Flexible piping connections.
  4. Seismic restraints for isolated equipment.
  5. Seismic restraints for non-isolated equipment.
  6. Certification of seismic restraint designs and installation supervision.
  7. Certification of seismic attachment of housekeeping pads.
  8. All mechanical, plumbing, fire protection and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical. (Equipment not listed is still included in this specification).

AC Units	Generators
Air Cooled Condensing Units	Heat Exchangers
Air Handling Units	Light Fixtures
Air Separators	Motor Control Ctrs
Battery Racks	Piping
Boilers	Pumps (all types)
Bus Ducts	Rooftop Units
Cable Trays	Switching Gear
Absorption Chillers	Tanks (all types)
Comp. Room Units	Transformers
Conduit	Unit Heaters
Cooling Towers	Unit Substations
Ductwork	Var. Freq. Drives
Dust Collectors	VAV Boxes
Electrical Panels	Water Heaters
Fans (all types)	Combined Heat and Power modules

- D. Definitions:
1. Life Safety Systems
    - a. All systems involved with fire protection including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and smoke exhaust systems.
    - b. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers, and all flowpaths to fire protection and/or emergency lighting systems.
    - c. All medical and life support systems.
    - d. Fresh air & relief systems on emergency control sequence including air handlers, conduit, duct, dampers, etc.

2. Positive Attachment
  - a. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double-sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, electrical conduit, bus duct, or cable trays, etc. are not acceptable as seismic anchor points.
3. Transverse Bracing
  - a. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.
4. Longitudinal Bracing
  - a. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

### 1.3 SUBMITTAL DATA REQUIREMENTS

- A. In addition to requirements of Section 01 33 00, the manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:
  1. Descriptive Data
    - a. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
    - b. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
  2. Shop Drawings
    - a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
    - b. Provide all details of suspension and support for ceiling hung equipment.
    - c. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
    - d. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
  3. Seismic Certification and Analysis
    - a. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.

- b. All restraining devices shall have a pre-approval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 450 to the weakest mode.
- c. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces required acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

#### 1.4 CODE AND STANDARDS REQUIREMENTS

- A. Typical Applicable Codes, Standards, and Categories:
  - 1. International Building Code 2015 with an effective peak acceleration coefficient of 0.15.
  - 2. Massachusetts State Building Code, Ninth Edition.
  - 3. Seismic hazard exposure group of I, II, III and seismic performance category of C, D.
  - 4. If the building is a Seismic Design Category B, seismic restraints are not required for any mechanical, electrical and plumbing systems. Vibration isolation is still required for all mechanical, electrical and plumbing systems.

#### 1.5 MANUFACTURER'S RESPONSIBILITY

- A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:
  - 1. Determine vibration isolation and seismic restraint sizes and locations.
  - 2. Provide vibration isolation and seismic restraints.
  - 3. Provide calculations and materials if required for restraint of unisolated equipment.
  - 4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

#### 1.6 RELATED WORK

- A. Housekeeping Pads:
  - 1. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

- B. Supplementary Support Steel:
  - 1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment.
- C. Attachments:
  - 1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

## 1.7 DESIGN REQUIREMENTS

- A. Design isolators for equipment installed outdoors to provide adequate restraint to withstand the force of a 100 mph wind applied to any exposed surface of the isolated equipment. Isolators for outdoor equipment shall have bolt holes for attachment to equipment and to supports. The vibration isolation Vendor shall submit verifying shear and over turning calculations, for their product and equipment installation arrangement, stamped by a licensed Professional Engineer. The design and supply of miscellaneous support steel above and below isolators will not be the responsibility of the vibration isolation manufacturer.

## 1.8 QUALITY ASSURANCE

- A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- B. Provide vibration isolators of the appropriate sizes, with the proper loading to meet the specified deflection requirements.
- C. Supply and install any incidental materials such as mounting brackets, attachments and other accessories as may be needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.
- D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- E. Should any rotating equipment cause excessive noise or vibration when properly installed on the specified isolators, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

## PART 2 - PRODUCTS

### 2.1 INTENT

- A. All vibration isolators and seismic restraints described in this section shall be the product of a single manufacturer. Mason Industry's products are the basis of these specifications; products of other manufacturers are acceptable provided their systems strictly comply with the specification.

- B. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8 inch and/or horizontal permanent deformation greater than 1/4 inch.

## 2.2 PRODUCT DESCRIPTIONS

- A. Vibration Isolators and Seismic Restraints.

### GENERAL:

1. All metal parts installed out-of-doors shall be corrosion resistant after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14.
2. Isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
3. Isolator types are scheduled to establish minimum standards. At the Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories and seismic restraint features must not degrade the isolation performance of the isolators.
4. Static deflection of isolators shall be as provided in the EXECUTION section and as shown on the drawings. All static deflections stated are the minimum acceptable deflection for the mounts under actual load. Isolators selected solely on the basis of rated deflections are not acceptable and will be disapproved.

### SPECIFICATION:

1. Two layers of 3/4" thick neoprene pad consisting of 2" square waffle modules separated horizontally by a 16 gauge galvanized shim. Load distribution plates shall be used as required. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.
2. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be Type BR as manufactured by Mason Industries, Inc.

3. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.
4. A one (1) piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
5. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.
6. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Pre-approval "R" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings. Mountings shall be SLR as manufactured by Mason Industries, Inc.
7. Spring mountings as in specification 5 built into ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4 inch travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be SSLFH as manufactured by Mason Industries, Inc.

8. Air Springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8". Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician. Air Springs shall be Type MT and leveling valves Type LV as manufactured by Mason Industries, Inc.
9. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc.
10. Hangers shall consist of rigid steel frames containing minimum 1 1/4" thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be type 30° as manufactured by Mason Industries, Inc.
11. Hangers shall be as described in specifications 10, but they shall be pre-compressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
12. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.



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13. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage pre-approval "R" number from OSHPD in the state of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be type SSB as manufactured by Mason Industries, Inc.

Note: Specifications 12 - 14 apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze. Specifications apply to hanging equipment as well.

14. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.
15. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose performed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
16. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4 inch thick. Rated loading shall not exceed 1,000 psi. A minimum air gap of 1/8 inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Snubber shall be Type Z-1 225 as manufactured by Mason Industries, Inc.
17. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" thick. Rated loadings shall not exceed 1,000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more than 1/4". Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" deflection in the x, y and z planes. Snubbers shall have an anchorage pre-approval "R" number from OSHPD in the state of California verifying the maximum certified horizontal and vertical load ratings. Snubbers shall be series Z-101 1 as manufactured by Mason Industries, Inc.

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18. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.0 Evaluation Service, Inc. verifying its allowable loads. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.
  19. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.0 Evaluation Service, Inc. verifying to its allowable loads. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.
  20. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump bases for split case pump shall include supports for suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14' provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1 ". Bases shall be type WF as manufactured by Mason Industries, Inc.
  21. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows. Bases shall be a minimum of 1/1 2 of the longest dimension of the base but not less than 6". The base depth need not exceed 1 2" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 6" centers running both ways in a layer 1 1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1 " clearance below the base. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable. Base shall be type BMK or K as manufactured by Mason Industries, Inc.
  22. Roof Curb (by HVAC Contractor)
    - a. Curb mounted rooftop equipment shall be mounted on structural spring isolation curbs that bear directly on the roof support structure, and are flashed and waterproofed into the roof's membrane waterproofing system. All spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal. Springs shall be Type A.
    - b. Unit shall be provided with wood nailer and flashing.
    - c. Curbs shall meet all NRCA Standards.
    - d. Curbs shall be similar to Novia Associates VibCurb III or equal having a minimum 3" rated static deflection and be 24" high.

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- e. Vibration control: The spring roof curb shall have the top isolated or floating rail attached in a manner to the fixed lower portion of the curb without short circuiting or bridging between the two. Restraining bolt(s) or threaded rod shall be of sufficient size to withstand the applied wind & or seismic forces at each spring pack location.
  - f. An alignment bolt shall be installed before connecting the floating to non-floating parts to guarantee perfect centering of the restraining bolts.
  - g. Weather proofing & air seal: The spring curb must keep the weather (air and water) out and any airflow from the RTU in. The weather seal must not have the ability to fail and allow water or air into the building.
  - h. The use of exposed exterior neoprene or some other elastomer material to seal the top floating rail from the base of the curb is not acceptable.
  - i. Vibration Mountings: Provide a rubber gasket covered by formed galvanized sheet metal top flashing that overhangs the top wood nailer and galvanized bottom flashing. The overlapping shall effectively cover the rubber gasket so it is protected from the elements.
  - j. The top flashing / support rail shall be 14 ga. G60-Zc steel formed with 90 bends that extend down to the wood nailer. Provide a counter flashing member with a sponge gasket attached that presses up against the horizontal bend. The seal shall be replaceable, protected from the elements and easy to install.
  - k. Curb side material: Provide 12 Ga. G60 galvanized steel for curb side construction. All side and end seam between sheets shall be continuously welded, corner joints to be caulked and bolted.
  - l. Structural Capability:
    - 1) Curbs shall be installed on metal decking/concrete slab. Air handling unit load shall be properly distributed. Coordinate curb construction with pitch of roof. Curbs shall be built to match the roof pitch in accordance with all requirements of this project. Positive attachment of the curb to the structure is imperative. Pitch correction shall be fabricated from 12 gauge galvanized material and be continuous on all sides and ends. Field fabricated and installed tube steel stub-ups are not acceptable. HVAC contractor shall provide detailed information to the curb manufacturer regarding pitch correction.
    - 2) Plenum Sections: The side material must be capable of handling the static pressure developed by the fans and not 'oil can'. Provide spanning bar joists as required to support plenum installation (even when the spring pockets are center span).
    - 3) Provide a continuous bottom tube steel member or side material of sufficient strength. Mechanical contractor shall coordinate and verify all dimensions, weights, roof penetrations, etc. with the Structural Engineer prior to installation.

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- 4) Curb Insulation: Provide spring curbs with a space between the floating and non-floating parts for the installation of insulation. Curb manufacturer shall provide factory installed insulation adhered to roof curb. Curbs shall be externally factory insulated with a 1.7" thick R-12 foam insulation, FM Class 1 and UL Class A Ratings, with bonded fiber reinforced facer.
- m. Protection: Curbs shall be completely shrink-wrapped during shipping.
  - n. Mechanical contractor shall provide all necessary materials to completely weather proof and sound proof the curb installation.
  - o. Additional features:
    - 1) Sound barrier: Provide a sound barrier package, consisting of G60 galvanized back-to-back angles. Sound barrier package shall be capable of supporting two layers of 1/2" concrete board with a maximum deflection over the width of the curb of L/360. Cement board furnished and installed by the HVAC Contractor. Overlap all joints, caulk all seams and edges. Transmission Loss & STC shall be as shown as follows. Sound Transmission Loss at Frequency (Cycles per second) of (125)=20, (250)=27, (500)=30, (1000)=32, (2000)=30, (4000)=38, (STC)=31.
    - 2) Provide with framed Supply & Return air duct openings. Openings shall match duct sizes and have 1" galvanized steel flanges.
    - 3) Plenum sections: Where indicated on the drawings and/or if substituted equipment connections differ from what's on the contract documents, provide in the interior of the curb, double wall acoustical floor, walls and plenum divider. All insulation shall be 2" thick fiber glass acoustical duct liner with reinforced coating system. Insulation acoustical performance shall be as follows. Liner shall not support microbial growth and shall be EPA registered and pass ASTM C 1071 & ASTM G21 bacterial tests conducted in accordance with ASTM G22. Floors up to 90" curb I.D. width shall be constructed of 22 Ga., 20 Ga. thereafter, solid G60 galvanized bottom panels and 22 Ga. galvanized perforated 22.7% open area top panel. Floor shall be attached to walls and plenum divider to provide an airtight plenum. Walls shall have 22 Ga. galvanized perforated 22.7% open area inside panels. Plenum divider shall be double wall 22 Ga. perforated galvanized 22.7% open area panel on the supply side with a 14 gauge solid panel opposite. Sound Absorption Coefficient at Frequency (Cycles per second) of (125)=.23, (250)=.64, (500)=.99, (1000)=1.05, (2000)=1.00, (4000)=.98, (NRC)=.90,

23. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Dacron tire cord friction ring. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16' to 24" may be single sphere. Sizes 3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190°F. with a uniform drop in allowable pressure to 190 psi at 250°F. 16" and larger connectors are rated 180 psi at 190°F. and 135 psi at 250°F. Safety factors to burst and flange pullout shall be a minimum of 3/1.

All joints must have permanent markings verifying a 5 minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints.

Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut off valves.

Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.

24. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

<u>Flanged</u>		<u>Male Nipples</u>	
3 x 14	10 x 26	1/2 x 9	1-1/2 x 13
4 x 15	12 x 28	3/4 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2-1/2 x 18
6 x 20	16 x 32	1-1/4 x 12	
8 x 22			

Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be type BSS as manufactured by Mason Industries, Inc.

25. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.
26. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of + 1 5/8" motion, or to meet location requirements. Pipe guides shall be type VSG as manufactured by Mason Industries, Inc.
27. Split Wall Seals consist of two bolted pipe halves with minimum 3/4" thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240°F., 10# density fiberglass may be used in lieu of the sponge. Seals shall be Type SWS as manufactured by Mason Industries, Inc.
28. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the duct work or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data. At the completion of all construction work the vibration and seismic device supplier shall inspect all installations and provided a written report of installation compliance to the engineer of record. A copy of this written certification shall also be provided in the operations manual provided to the owner.
- B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.
- C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

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- D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
  - E. Coordinate work with other trades to avoid rigid contact with the building.
  - F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractors expense.
  - G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractors expense.
  - H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractors expense.
  - I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
    - 1. Flanges of structural beams.
    - 2. Upper truss cords in bar joist construction.
    - 3. Cast in place inserts or wedge type drill-in concrete anchors.
  - J. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.
  - K. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.
  - L. At locations where specification 12 or 13 restraints are located, the support rods must be braced when necessary to accept compressive loads with specification 14 braces.
  - M. At all locations where specification 12 or 13 restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with specification type 15 braces.
  - N. Drill-in concrete anchors for ceiling and wall installation shall be specification type 18, and specification type 19 female wedge type for floor mounted equipment.
  - O. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project.
  - P. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed specification 23 capabilities.
  - Q. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide specification 27 wall seals.
  - R. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight.

Horizontal thrust restraint shall be specification type 28.

- S. Locate isolation hangers as near to the overhead support structure as possible.

3.2 VIBRATION ISOLATION AND SEISMIC RESTRAINT OF PIPING, DUCTWORK, AND CONDUIT

- A. Where piping connects to rotating or vibrating mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.

B. Seismic Restraint of Piping:

1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables.
  - a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping.
  - b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" I.D. and larger.
  - c. All other piping 2 1/2" diameter and larger.
1. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
2. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
4. For fuel oil and all gas piping transverse restraints must be at 20' maximum and longitudinal restraints at 40' maximum spacing.
5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or TEE or combined stresses are within allowable limits at longer distances.
6. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
7. Branch lines may not be used to restrain main lines.



C. Pipe Isolation

1. All chilled water, condenser water, hot water, steam, refrigerant, drain and engine exhaust piping that is connected to vibration-isolated equipment shall be isolated from the building structure within the following limits:

Within mechanical rooms;

Within 50' total pipe length of connected vibration-isolated equipment (chillers, pumps, air handling units, pressure reducing stations, etc.);

At every support point for piping that is greater than 4 inches in diameter.

2. Piping shall be isolated from the building structure by means of vibration isolators, resilient lateral supports, and resilient penetration sleeve/seals.
3. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than 1/2", Type FSN or HSN isolators shall be used. When the required static deflection is less than or equal to 1/2", Type FN or HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving at least 1/4" static deflection.
4. Where lateral support of pipes is required within the specified limits, this shall be accomplished by use of resilient lateral supports.
5. Pipes within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
6. Provide flexible pipe connections as called for under Major Equipment above and wherever shown on the drawings.

D. Seismic restraint of ductwork:

1. Seismically restrain all duct work with specification 12 or 13 restraints as listed below:
  - a. Restrain rectangular ducts with cross sectional area of 6 sq. ft. or larger.
  - b. Restrain round ducts with diameters of 28" or larger.
  - c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
    - 1) Transverse restraints shall occur at 30' intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
    - 2) Longitudinal restraints shall occur at 60' intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4' of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
    - 3) The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.

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- 4) A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
  - 5) Walls, including gypsum board non bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
- E. Duct Isolation:
1. All sheet metal ducts and air plenums that are within mechanical rooms or within a distance of 50' total duct length of connected vibration-isolated equipment (whichever is longer) shall be isolated from the building structure by Type FN, PCF or HN isolators. All isolators shall achieve 0.1" minimum static deflection.
  2. Ducts within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
  3. Flexible duct connections shall be provided as called for above under Major Equipment and wherever shown on the drawings.
- F. Seismic Restraint of Electrical Services:
1. All electrical conduit 2-1/2" in diameter and larger shall be restrained with specification type 12 seismic cable restraints or specification type 13 for seismic solid brace restraints.
  2. All electrical bus ducts, cable trays and ladder trays shall be restrained with specification type 12, seismic cable restraints or specification 13 seismic solid brace restraints.
  3. Transverse restraints shall occur at 30' intervals or both ends if the electrical run is less than the specified interval. Transverse restraints shall be installed at each electrical services turn and at each end of the electric run.
  4. Longitudinal restraints shall occur at 60' intervals with at least one restraint per electric run. Transverse restraints for one electric section may also act as a longitudinal restraint for a duct for an electric section connected perpendicular to it if the restraints are installed within 4' of the intersection of the electric run and if the restraints are sized for the larger electric run.
  5. All rigid floor mounted equipment must have a resilient media between the equipment mounting hole and the anchor bolt. Neoprene bushings shall be specification type 4 and anchor bolts shall be specification type 18 or 19.
  6. Wall mounted panels shall be mounted with specification type 3 bushings. Floor mounted panels shall be mounted on specification type 4 bushings. Anchor bolts shall be specification type 18 or 19.
- G. All fire protection piping shall be braced in accordance with NFPA 13 and 14.
- H. All mechanical equipment shall be vibration isolated and seismically restrained.
1. All fire protection equipment is considered life safety equipment and shall be seismically restrained.

### 3.3 SEISMIC RESTRAINT EXCLUSIONS

- A. Piping:
  - 1. All piping less than 2 1/2" except for gas and fire protection piping.
  - 2. All piping in boiler and mechanical equipment rooms less than 1 1/4" I.D.
  - 3. All clevis or trapeze supported piping suspended from hanger rods where the point of attachment is less than the 12" in length from the structure to the structural connection of the clevis or trapeze.
    - a. All PVC and fiberglass suspended waste or vent pipe 6" in diameter and smaller.
- B. Ductwork:
  - 1. Rectangular, square or oval ducts less than 6 sq.ft. in cross sectional area.
  - 2. Round duct less than 28" in diameter.
  - 3. Duct supported by hanger rods where the point of attachment is less than 12" in length from the structure to the structural connection of the duct work.
- C. Electrical:
  - 1. All conduit less than 2 1/2" diameter suspended by individual hanger rods.
  - 2. All clevis or trapeze supported conduits suspended by hanger rods where the point of attachment is less than 1 2" in length from the structure to the structural connection of the clevis or trapeze.

### 3.4 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

- A. General
  - 1. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment as well as for proper operation.
  - 2. Installation of vibration isolation equipment shall be in accordance with the manufacturer's instructions.
- B. Isolators
  - 1. All vibration isolators shall be aligned squarely above or below mounting points of the supported equipment.
  - 2. Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
  - 3. Locate isolators to provide stable support for equipment, without excess rocking.
  - 4. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called for herein.
  - 5. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plates shall rest entirely on the pad.
  - 6. Hanger rods for vibration-isolated support shall be connected to major structural members, not the floor slab between major structural members. Provide suitable intermediate support members as necessary.

7. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360° about the rod axis without contacting any object.
8. Parallel running pipes may be hung together on a trapeze that is isolated from the building. Isolator deflections must be the greatest required by the provisions for pipe isolation for any single pipe on the trapeze. Do not mix isolated and unisolated pipes on the same trapeze.
  - a. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.
  - b. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
  - c. The installed and operating heights of equipment supported by Type FSNTL isolators or with Type RC-2 isolation bases shall be identical. Limit stops shall be out of contact during normal operation. Adjust isolators to provide 1/4" clearance between the limit stop brackets and the isolator top plate, and between the travel limit nuts and travel limit brackets.
  - d. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases

1. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by the equipment manufacturer. This provision shall apply whether or not a base frame is called for on the schedule. In the case that a base frame is required for the unit because of the equipment manufacturer's requirements and is not specifically called for on the equipment schedule, a base frame recommended by the equipment manufacturer shall be provided at no additional expense.
2. Unless otherwise indicated, there is to be a minimum operating clearance of 1" between steel rails, steel frame bases or inertia bases and the floor beneath the equipment. The isolator mounting brackets shall be positioned and the isolators adjusted so that the required clearance is maintained. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.
3. Isolation bases shall be installed in strict accordance with the manufacturer's instructions.

D. Flexible Duct Connections:

1. Prior to installation of the flexible connection, sheet metal ducts and plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section, and the gap between connected parts shall be uniform. Flexible duct connections shall not be installed until this provision is met. There shall be no metal-to-metal contact between connected sections, and the fabric shall not be stretched taut.

- E. Flexible Pipe Connections:
  - 1. Install flexible pipe connections in strict accordance with the manufacturer's instructions.
  
- F. Thrust Restraints:
  - 1. Thrust restraints shall be attached on each side of the fan parallel to the thrust force. This may require custom brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Thrust restraints shall be adjusted to constrain equipment movement to the specified limit.
  
- G. Grommets:
  - 1. Where grommets are required at hold down bolts of isolators, bolt holes shall be properly sized to allow for grommets. The hold down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers shall be galvanized.
  
- H. Resilient Penetration Sleeve/Seals:
  - 1. Maintain an airtight seal around the penetrating element and prevent rigid contact between the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

End of Section

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Section 23 08 00

COMMISSIONING OF HVAC SYSTEMS

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
- B. The OPR and BOD documentation are included by reference for information only.

1.2 SUMMARY

- A. This section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
  - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "General Commissioning Requirements" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's role.
- B. Refer to Division 01 Section "Submittals" for specific requirements. In addition, provide the following:
- C. Certificates of readiness
- D. Certificates of completion of installation, prestart, and startup activities.
- E. O&M manuals
- F. Test reports

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

**PART 2 - PRODUCTS**

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC&R system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.



### **PART 3 - EXECUTION**

#### **3.1 GENERAL DOCUMENTATION REQUIREMENTS**

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems
- B. Red-lined Drawings: The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. Operation and Maintenance Data: Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.
- D. Demonstration and Training: Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior to the training session

#### **3.2 CONTRACTOR'S RESPONSIBILITIES**

- A. Perform commissioning functional test procedures at the direction of the CxA. This includes but is not limited to the controls contractor verifying with the CxA that all sequences of operations are functioning properly.
- B. Attend construction phase controls coordination meetings.
- C. Attend testing, adjusting, and balancing review and coordination meetings.
- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation. This may include but is not limited to pipe pressure tests, duct leakage tests and flushing / cleaning reports.
- F. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- G. Prepare preliminary schedule for Mechanical system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe and duct system

testing, flushing and cleaning, equipment start-up, testing and balancing and task completion for owner. Distribute preliminary schedule to commissioning team members.

- H. Update schedule as required throughout the construction period.
- I. Assist the CxA in all verification and functional performance tests. While the CxA is onsite the contractor does not need to be with the CxA throughout the entire day but only needs to be available if assistance is needed (such as turning a piece of equipment on). The exception is that the controls contractor is expected to verify all sequences of operation with the CxA.
- J. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- K. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
- L. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
- M. Notify the CxA a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.
- N. Participate in, and schedule vendors and contractors to participate in the training sessions.
- O. Provide written notification to the CM/GC and CxA Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
- P. The equipment supplier shall document the performance of his equipment.
- Q. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
- R. Test, Adjust and Balance Contractor
  1. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
  2. Submit the site specific testing and balancing plan to the CxA and AE for review and acceptance.
  3. Attend the testing and balancing review meeting scheduled by the CxA. Be prepared to discuss the procedures that shall be followed in testing, adjusting, and balancing the HVAC&R system.
  4. At the completion of the testing and balancing work, and the submittal of the final testing and balancing report, notify the HVAC&R contractor and the CM/GC.
  5. At the completion of testing and balancing work, and the submittal of the final testing and balancing report, notify the HVAC&R Contractor and the CM/GC.
  6. Participate in verification of the testing and balancing report, which will consist of repeating measurements contained in the testing and balancing reports. Assist in diagnostic purposes when directed.

- S. Equipment Suppliers
  - 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
  - 2. Assist in equipment testing per agreements with contractors.
  - 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
  
- T. Refer to Division 01 Section "General Commissioning Requirements" for additional contractor responsibilities.

### 3.3 CxA'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's Responsibilities.

### 3.4 TESTING PREPARATION

- A. Certify in writing to the CxA that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the CxA that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.5 TESTING, ADJUSTING AND BALANCING VERIFICATION

- A. Prior to performance of Testing, Adjusting and Balancing work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least ten (10) days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
  - 1. The CxA will notify testing and balancing subcontractor ten (10) days in advance of the date of field verification. Notice will not include data points to be verified.
  - 2. The testing and balancing subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
  - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
  - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

### 3.6 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R contractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

### 3.7 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 23 sections. Provide submittals, test data, inspector record, and certifications to the CxA.
- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections. Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment: Test requirements are specified in Division 23 piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
  2. Description of equipment for flushing operations.
  3. Minimum flushing water velocity.
  4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- E. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- F. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.
- G. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

***HVAC Systems***

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Boilers
Chillers
Piping
Heat Exchangers
Pumps and drives
Air handler systems
Roof Top Units
Heating and ventilating units
Induction Units
Displacement terminal units
Unit Ventilators
Cabinet unit heaters
Fan coil units
Unit heaters
Radiant panels
Finned tube radiation
Convectors
Chilled Beams
Exhaust fans
Combustion air units
Split system AC
Make-up air units
Fume hoods
Heat recovery systems
Thermal Solar Systems
Testing, adjusting and balancing spot check
Automated temperature controls and energy management systems
<b>Building Automation and Controls</b>
Interface of these systems with HVAC systems, fire alarm and security systems.

3.8 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.9 APPROVAL

- A. Refer to Division 01 Section "General Commissioning Requirements" for approval procedures.

3.10 DEFERRED TESTING

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deferred testing.

3.11 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 Section "General Commissioning Requirements" for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.12 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to training.

End of Section

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ELECTRICAL  
(Filed Sub-Bid Required)

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Section 26 00 10  
ELECTRICAL  
(Filed Sub-Bid Required)

**PART 1 - GENERAL**

1.1 GENERAL PROVISIONS

A. Time, Manner and Requirements for Submitting Sub-Bids:

1. Sub-bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Owner at a time and place as stipulated in the "NOTICE TO CONTRACTORS".

The following should appear on the upper left hand corner of the envelope:

NAME OF SUB-BIDDER: (Insert name of sub-bidder)

SUB-BID FOR SECTION: 26 00 10 – ELECTRICAL

2. Each sub-bid submitted for work under this Section shall be on forms furnished by the Owner as required by Section 44F of Chapter 149 of the General Laws, as amended. Sub-bid forms may be obtained at the office of the Owner.
3. Sub-bids filed with the Owner shall be accompanied by BID BOND or CASH or CERTIFIED CHECK or TREASURER'S CHECK or CASHIER'S CHECK issued by a responsible bank or trust company payable to the Town of Framingham in the amount of five percent of the sub-bid. A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.

B. Sub Sub-Bid Requirements:

1. Sub-bidders' attention is directed to Massachusetts General Laws, Chapter 149, Section 44F as amended which provides in part as follows:
  - a. Each sub-bidder shall list in Paragraph E of the "form for Sub-bids" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which (the Section of the specifications for that sub-trade) requires such listing; provided that, in the absence of a contrary provision in the Specifications, any sub-bidder may, without listing any bid price, list his/her own name in said paragraph E for any such class of work or part thereof and perform that work with persons on his/her own payroll; if such sub-bidder, after sub-bid openings, shows to the satisfaction of the awarding authority that s/he does customarily perform such class of work or the part thereof with persons on his/her own payroll and is qualified so to do. This Section of the Specifications requires that the following classes of work shall be listed in paragraph E under the conditions indicated herein.

CLASSES OF WORK REFERENCE	PARAGRAPH
Technology	27 00 00
Integrated Electronic Security System	28 00 00

- C. Reference Drawings: The Work of this Filed Sub-Bid is shown on the following Contract Drawings: E001, E002, E003-1, E003-2, E004, E005, E101A, E101B, E101C, E101D, E102A, E102B, E102C, E102D, E103A, E103B, E103C, E103D, E201A, E201B, E201C, E201D, E202A, E202B, E202C, E202D, E203A, E203B, E203C, E203D, E204, E205, E300, E301, E302, E303, E304, E305, E306, E307, E400, E401A, E401B, E401C, E401D, E402A, E402B, E402C, E402D, E403A, E403B, E403C, E403D, E500, E501A, E501B, E501C, E501D, E502A, E502B, E502C, E502D, E503A, E503B, E503C, E503D, E504, T001, T101A, T101B, T101C, T101D, T102A, T102B, T102C, T102D, T103A, T103B, T103C, T103D, T201, T202, T300, & T301

## 1.2 RELATED DOCUMENTS

- A. All of the Contract Documents, including Drawings, General and Supplementary Conditions and Division 01 - General Requirements, apply to the Work of this Section.
- B. Carefully examine all of the Contract Documents for requirements which affect the Work of this Section. The exact scope of Work of this Section cannot be determined without a thorough review of all specification Sections and other Contract Documents.
- C. Refer to Section 012300, Alternates, for alternates which may affect the work of this Section.

## 1.3 DESCRIPTION OF WORK

- A. Work described herein shall be interpreted as work to be done by the Electrical Subcontractor. Work to be performed by other trades will be referenced to a particular contractor or subcontractor.
- B. Provide all labor, materials, tools, and equipment, including scaffolding, to complete the installation of the electrical system. Install, equip, adjust, and put into operation the respective portions of the installation specified, and so interconnect various items or sections of work in order to form a complete and operating whole. Provide all necessary coordination with other trades and the architect. Systems may reference in singular or plural terms, also refer to drawings confirm quantities. The work shall consist of, but shall not necessarily be limited to, the following:
  1. Primary, secondary and low tension ductbanks, manholes, and handholes.
  2. Secondary distribution equipment, including secondary switchboard and metering, motor controls, Variable Frequency Drives, dry-type transformers, distribution panels, and panelboards, including feeders and subfeeders.
  3. Fire alarm system, including Mass Notification System.
  4. Emergency power system, including diesel fueled emergency generator, emergency lighting and exit signs.
  5. Lighting systems exterior and interior, fixtures, and controls. Electrical Subcontractor shall conduct a light level review in the field to ensure luminaires and their footcandle readings are in accordance with project criteria and the IESNA.
  6. All raceway systems, including boxes, couplings, and fittings.

7. All branch circuit wiring systems, including wiring devices, and plates.
8. Excavation and backfill within building foundation walls for any underground raceways.
9. Connections for all building equipment, including mechanical, plumbing, fire protection, elevators, and the like.
10. All testing of equipment installed. Provide and coordinate required electrical manufacturer's site testing and installation verifications. Identify and coordinate any Factory testing and make provisions for necessary site personnel (e.g., maintenance personnel, client, Cx agent, and engineer of record) to attend FAT execution.
11. Any other item of work hereinafter specified or indicated on electrical drawings.
12. Drilling, coring, and cutting of holes for electrical conduit, systems, and equipment, where the largest dimension thereof does not exceed 8" in diameter or the equivalent of cross-sectional area of 8" x 8" for cutting or coring. All sleeve or boxouts, regardless of size shall be provided by Electrical Sub-contractor.
13. Systems Identification.
14. Install Stage Dimming and lighting system, furnished by Stage Lighting/Rigging Contractor under Sections 116133, 116191, and 266111. Provide all conduit, both low and high voltage, high voltage wire and terminations. Refer to equipment shown on TL Series.
  - a. Provide all conduit, both control and high voltage, high voltage wire and controls for motorized batten hoists over the audience seating area. Batten hoists furnished and installed by Section 116133 contractor. Refer to equipment shown on TR Series.
  - b. Provide all conduit, both control and high voltage, high voltage wire and terminations for motorized batten hoists over the stage area. Batten hoists furnished and installed by Section 116133 contractor. Refer to equipment shown on TR Series.
  - c. The matrix of responsibilities indicated in Paragraph 2.9 is intended as a guide for delineating the work between the Electrical Contractor and the Stage Lighting/Rigging Contractor, Sections 116133, 116191, and 266111.
  - d. Receive and store dimming system equipment supplied by the Section 116191 Contractor.

15. Hoisting Equipment and Machinery: Unless otherwise specified, all hoisting equipment and machinery required for the proper and expeditious prosecution and progress of the work shall be furnished, installed, operated and maintained in safe condition by the individual Non Trade and Trade Contractors and is so stated in each appropriately related Section of the Specifications. All costs for hoisting operating services shall be borne by the Non Trade and Trade Contractors unless specifically excepted in the Contract Documents.
  - a. A licensed equipment manufacturer's representative shall be present at all times, to witness the erection and dismantling of all hoisting equipment and machinery, whenever such equipment is being erected or dismantled. No such work will be performed without the presence of such representative.
  - b. Hoisting equipment and machinery erection and dismantling shall be performed only by trained, certified, and experienced riggers qualified to perform such work.
16. Staging and Scaffolding: All staging, planking and scaffolding, exterior and interior, required for the proper execution of the work and over eight feet in height, shall be furnished, installed, and maintained by the General Contractor.
  - a. All staging up to eight feet in height shall be provided by the individual Non Trade and Trade Contractors as applicable to their work.
17. Provide Seismic Restraints for all Electrical Systems conforming to the requirements of Section 230548 which Section is herein incorporated by reference.
18. Coordination Drawings, refer to Section 013100.
19. Communications cable tray, outlet boxes and raceway system provisions including voice, data, paging, intercom, and clock. as indicated on drawings and specified in Section 270000.
20. Temporary Power and Lighting, Section 015000. Refer to Section 015000 for temporary power and lighting.
21. Alternates affecting this section.
22. Raceways system provisions for Technology systems including outlet boxes, raceway system, 120 volt sources as indicated on drawings. Raceways system provisions for Technology systems including outlet boxes, raceway system, 120 volt sources as indicated on drawings and specified in Section 270000.
23. Raceways system provisions for Integrated Electronic Security System including outlet boxes, raceway system, 120 volt sources as indicated on drawings. Raceways system provisions for Integrated Electronic Security System including outlet boxes, raceway system, 120 volt sources as indicated on drawings and specified in Section 280000.
24. Raceways system provisions for Audiovisual Systems including outlet boxes, raceway system, 120 volt sources as indicated on drawings. Raceways system provisions for Audiovisual Systems including outlet boxes, raceway system, 120 volt sources as indicated on drawings and specified in Section 274100.

25. Sustainable Design Intent: Comply with project requirements intended to achieve sustainable design, measured and documented according to the LEED Green Building Rating System, of the US Green Building Council. Refer to Section 018113, SUSTAINABLE REQUIREMENTS SUMMARY and 018111 LEED V4 CHECKLIST for certification level and certification requirements.
26. Section 019113 – General Commissioning Requirements and Section 260800 - Commissioning of Electrical Systems are included as work of this Section. Provide all necessary technical and material support for the commissioning of the project's electrical components and systems.
27. Firestop systems in accordance with section 078400 – Firestopping.
28. Power wiring to Variable Frequency Drivers, refer to Section 230000 Automatic Temperature Controls.
29. Power wiring to gas and water sub-meters, refer to section 230000.
30. Lightning preventor system

#### 1.4 DEFINITIONS

- A. Most terms used within the documents are industry standard. Certain words or phrases shall be understood to have specific meanings as follows:
  1. Provide: Furnish and install completely connected up and in operable condition.
  2. Furnish: Purchase and deliver to a specific location within the building or site.
  3. Install: With respect to equipment furnished by others, install means to receive, unpack, move into position, mount and connect, including removal of packaging materials.
  4. Conduit: Raceways of the metallic type which are not flexible. Specific types as specified.
  5. Connect: To wire up, including all branch circuitry, control and disconnection devices so item is complete and ready for operation.
  6. Subject to Mechanical Damage: Equipment and raceways installed exposed and less than eight feet above finished floor in mechanical rooms or other areas where heavy equipment may be in use or moved.

#### 1.5 ITEMS TO BE FURNISHED ONLY

- A. Furnish the following items for installation under designated sections.
  1. Duct smoke detectors with sampling tube – Section 230000 – HVAC.

#### 1.6 ITEMS TO BE INSTALLED ONLY

- A. Install the following items furnished under designated sections.
  1. Specialty backboxes – Section 270000.
  2. Power operated window shades – Section 122414.

## 1.7 RELATED WORK SPECIFIED ELSEWHERE

- A. The following related work is to be performed under designated sections.
1. LEED for school requirements: Refer to Section 018113 – SUSTAINABLE REQUIREMENTS SUMMARY and Section 018111 - LEED V4 CHECKLIST and Division 01 – GENERAL REQUIREMENTS.
  2. Temp. Controls: Section 015000.
  3. Excavation and Backfill (except within building foundation): DIVISION 31 - EARTHWORK.
  4. Pads and Duct Envelopes: SECTION 033000 – CAST-IN-PLACE CONCRETE.
  5. Insulation: SECTION 072100 – THERMAL INSULATION.
  6. Finish Painting: SECTION 099100 – PAINTING.
  7. Cutting beyond 1.3, B.12 above and patching of all openings regardless of size shall be by trade responsible for Section on which penetration occurs.
  8. Automatic Temperature Control: SECTION 230000 – AUTOMATIC TEMPERATURE CONTROLS.
  9. Hardware: SECTION 087100 – DOOR HARDWARE.
  10. Technology Wiring and Equipment: SECTION 270000 – TECHNOLOGY.
  11. Integrated Electrical Security System Wiring: Section 280000 - Integrated Electronic Security System.
  12. Power Operated Shades – SECTION 122400 – WINDOW SHADES
  13. Section 019113 – Building Commissioning Requirements and Section 260800 – Commissioning of Electrical Systems.
  14. For coordination with structural trusses refer to Section 05 44 00 – Cold-Formed Metal Trusses for required layout coordination.
  15. Temporary Power and Lighting: Section 015000.
  16. Sustainable Design:
    - a. Section 017419 – Construction Waste Mgmt. and Disposal
    - b. Section 018113 - Sustainable Requirements Summary
    - c. Section 018111 - LEED V4 for Schools Project Checklist
    - d. Section 018112 - LEED Documentation Requirements
    - e. Section 018119 – Construction Indoor Air Quality Management
    - f. Definitions: Refer to Section 018113 “Sustainable Requirements Summary” and Section 018111 “LEED V4 for Schools Project Checklist” for definitions of terms used in this section.

## 1.8 ENVIRONMENTAL REQUIREMENTS

- A. The work of this section shall comply with requirements of the following:
1. SECTION 013100 – PROJECT MANAGEMENT AND COORDINATION
  2. SECTION 014100 – REGULATORY REQUIREMENTS
  3. SECTION 018113 – SUSTAINABLE REQUIREMENTS SUMMARY and SECTION 018111 - LEED V4 FOR SCHOOLS PROJECT CHECKLIST



1.9 CONTRACT COST BREAKDOWN

- A. Submit a breakdown of contract price to aid Architect in determining value of work installed as job progresses.

1.10 INSPECTION OF SITE

- A. Electrical bidders will be permitted to inspect site. Failure to inspect existing conditions or to fully understand work which is required shall not excuse
- B. Electrical Subcontractor from his obligations to supply and install work in accordance with specifications and the drawings and under all site conditions as they exist.

1.11 CONTRACTOR'S REPRESENTATIVE

- A. Retain a competent representative on the project. Do not substitute representative without prior approval from Owner.

1.12 COOPERATION

- A. Work shall be carried on under usual construction conditions, in conjunction with other contractors work. Cooperate with other contractors, coordinate work and proceed in a manner as not to delay progress.
- B. Before proceeding, examine all construction drawings and consult other contractors to coordinate installation and avoid interference.
- C. In case of dispute, the Architect will render a decision in accordance with General and Supplementary General Conditions.

1.13 CODES, ORDINANCES, AND PERMITS

- A. Codes and Ordinances:
  - 1. All material and work provided shall be in accordance with the following codes and standards as most recently amended.
  - 2. Commonwealth of Massachusetts Building Code
  - 3. Massachusetts Electric Code, 2017 Edition
  - 4. State Department of Public Safety
  - 5. NFPA 101 "Life Safety Code"
  - 6. NFPA Standards
  - 7. Standards of the Underwriters Laboratories (UL)
  - 8. Occupational Safety and Health Act (OSHA)
  - 9. Americans with Disabilities Act (ADA)
  - 10. Energy Conservation Code
  - 11. City of Framingham
  - 12. NETA, National Electrical Testing Association
  - 13. Where contract documents indicate more stringent requirements than codes, the contract documents shall take precedence.

- B. Permits: Be responsible for filing documents, and securing of inspection and approvals. Pay all local connection & permit fees. Costs related to temporary service, refer to Division 00. Refer to AIA 201 General Conditions.

#### 1.14 ELECTRICAL ROOMS OR SPACES

- A. Be responsible for ensuring that the dedicated space and clearances required in the NEC, Section 110-26 are maintained for all electrical equipment.
- B. Call other contractors' attention to the requirements contained in the above mentioned code sections, prior to the installation of equipment by other contractors, in order to ensure no violations.

#### 1.15 SUBMITTALS

- A. Refer to Section 013300 – SUBMITTAL PROCEDURES, for requirements.

#### 1.16 GUARANTEE

- A. All parts of the work shall be guaranteed for a period of one year from the date of acceptance of the job by Owner. If during that period of general guaranty, any part of the work fails, becomes unsatisfactory, or does not function properly due to any fault in material or workmanship whether or not manufactured or job built, the Owner shall upon notice from owner promptly proceed to repair or replace such faulty material or workmanship without expense to owner, including cutting, patching, and painting, or other work involved, and including repair or restoration of any damaged sections of the premises resulting from such faults.
- B. In the event that a repetition of any one defect occurs indicating the probability of further failure and which can be traced to faulty design, material, or workmanship, then repair or replacement shall not continue to be made but the fault shall be remedied by a complete replacement of the entire defective unit.
- C. In addition to the general guaranty, obtain and transmit to owner any guaranties or warranties from manufacturers of specialties, but only as supplementary to the general guaranty which will not be invalidated by same.
- D. Electrical Contractor is responsible to provide and/or install the correct designated equipment, components, and materials. Submittal approval by the engineer does not relieve the contractor from any contractual requirement to provide a complete and fully working system.

#### 1.17 ELECTRICAL CHARACTERISTICS

- A. In general, and unless specifically indicated otherwise, all building service, heating, ventilating, air conditioning, and plumbing equipment shall be of the following characteristics:
- B. Power Factor: All equipment provided rated greater than 1,000 watts and lighting equipment greater than 15 watts with an inductive reactance load component shall have a power factor of not less than 90 percent under rated load conditions.
  - 1. Motors up to and including 1/3 HP shall be suitable for 120 volts, single phase operation.

2. Motors larger than 1/3 HP shall be suitable for 480 volts, three phase operation.
3. Electric heating equipment 4 KW and less shall be suitable for 277 volt single phase operation. Over 4 KW shall be 480 volt three phase.

1.18 TEMPORARY LIGHT & POWER

- A. Refer to Division 00.

1.19 TEMPORARY ELECTRICAL SUPPORT FACILITIES

- A. Refer to Division 00.
- B. Provide own field office and/or storage facilities which shall be located as directed or permitted by General Contractor and in accordance with local regulations. Provide all tools, equipment, ladders, and temporary construction required for execution of the work.
- C. All scaffolding, ladders, and other temporary construction shall be rigidly built in accordance with all local and state requirements, and shall be removed upon completion.

1.20 INSPECTIONS AND TESTS

- A. Inspection: If inspection of materials installed shows defects, such defective work, materials, and/or equipment shall be replaced and inspection and tests repeated.
- B. Tests: Make reasonable tests and prove integrity of work and leave electrical installation in correct adjustment and ready to operate. All panels and switchboards shall have phases balanced as near as practical. A consistent phase orientation shall be adhered to at all terminations.
- C. Provide and coordinate required electrical manufacturer's site testing and installation verifications. Site testing protocols shall be submitted by the applicable vendor PRIOR to commencement of site tests. All completed site testing is to be properly documented with test reports submitted as a Cx pre-requisite. Identify any Factory testing and make provisions for necessary site personnel (e.g., maintenance personnel, client, Cx agent, and engineer of record) to attend FAT execution.
- D. Provide all necessary technical and material support for the commissioning of the project's electrical components and systems. After establishing a general project schedule, add pertinent details of the commissioning workplan, incorporating necessary Cx predecessors, successors, and durations. Obtain/execute/submit all required documentation necessary for Cx to commence

1.21 ENERGY REBATE PROGRAM

- A. This project has been designed to incorporate equipment approved for energy rebate such as fixtures, performance lighting, building lighting controls, and VFDs. Meet with Utility Company prior to lighting shop drawing submittal to ascertain that submittal meets program guidelines. Fixtures shall be DLC listed or equivalent. Assist Owner and Engineer in effort to obtain utility rebates the Owner is eligible for. Equivalent lighting fixtures which meet DLC shall require lighting vendor to submit shop drawings to utility company for approval. It is the intent of this project to Qualify for incentives which requires an additional 30 days of reported kWh saved and six months of lighting energy use data as reported by the system post-installation.

1.22 INFORMATION TECHNOLOGY SYSTEM (I.T.S.) and SECURITY SYSTEM PROVISIONS

- A. Electrical Sub-contractor shall work closely with the I.T.S. Sub-contractor, and Security System Sub-contractor to assure a first class installation. Coordinate all back boxes and conduits required prior to installations. In general, the Electrical Subcontractor shall provide conduits from systems outlets to accessible ceiling space.
- B. The Electrical Subcontractor shall be responsible for providing all related building preparation including, but not limited to: power, cable trays, conduits with bushings, conduit stubs with bushings, sleeves with bushings (all conduit, stubs, and sleeves, shall be brought to an accessible ceiling of the same floor), backboxes, pull strings, bonding, grounding, for a completely operational system, as specified and shown on Drawings.

1.23 RECORD DRAWINGS

- A. Refer to Section 017700 – CLOSEOUT PROCEDURES for requirements.

1.24 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Refer to Division 01 – General Requirements.

1.25 STAGING AND SCAFFOLDING

- A. Staging and scaffolding shall be of engineered design adequate and suitable for the intended purpose and loading and in compliance with all applicable Federal, State and local laws and regulations, shall have all accident prevention devices and other features required by Federal, State and local laws and regulations, and shall be erected, maintained and removed by experienced scaffolding/staging builders.
- B. Each Trade Contractor entering upon the Work shall furnish, erect and maintain all staging and scaffolding required for work under his subcontract. Each Trade Contractor shall provide access to staging and scaffolding for all inspections by the Owner, OPM, Commissioning Agent or Inspection Agency. Each Trade Contractor shall dismantle and remove such staging and scaffolding on completion of his work and at other times as necessary to accommodate and facilitate orderly progress of the Work including work by other trades.

- C. The General Contractor shall furnish, erect and maintain all staging and scaffolding related to work within the top floor ceiling of the interior central stair space. The scaffolding at this location shall be coordinated and scheduled to be installed to best and most efficiently be utilized by all trades. The General Contractor shall be responsible to dismantle and remove staging and scaffolding and shall notify trades prior to removal. Any trades not utilizing the scaffolding during the allotted time shall be responsible to provide scaffolding for their work.

1.26 RETURN AIR PLENUM

- A. All wiring systems in areas above hung ceiling shall either be run in conduit or shall be "UL listed" plenum cable.

1.27 CUTTING AND PATCHING

- A. Penetrations through construction for the Work of this Section:
  - 1. Coring/Cutting: Perform all coring for required work up to and including 8" in diameter or equivalent in area of 8" square. Coring beyond 8" or cutting beyond the equivalent of 8" square will be performed by the General Contractor.
  - 2. Notify Masonry Sub-Contractor of exact locations and sizes for openings required in masonry, to be executed under Section 042000 – Unit Masonry, utilizing lintels furnished per Section 055000 – Metal Fabrications.
  - 3. Cut openings in new and existing non-masonry construction where required for penetrations. All cutting shall conform to the requirements of Section 01 73 00 EXECUTION, and 024119 – Demolition.
  - 4. Refer to Section 024119 – Demolition for restrictions on all alterations to structural elements.
- B. Patching at penetrations through construction for the Work of this Section:
  - 1. Notify Masonry Sub-Contractor when plumbing work is complete at penetrations through masonry construction, and ready for patching under Section 042000 – Unit Masonry.
  - 2. Notify appropriate Sub-Contractors when plumbing work is complete at penetrations through non-masonry construction, and ready for patching under Sections in Division 09 - FINISHES.
- C. Drilling, coring, and cutting of new and existing structures (through walls, floors, ceiling) where the largest dimension does not exceed 8 in. diameter for drilling/coring or the equivalent of an area equal to or less than 8" square shall be by the Electrical Subcontractor.
- D. Throughout the performance of the cutting and coring work, ensure that the structural integrity of the existing walls, floors, overhead structure, and other structural components, which are to remain, is maintained until permanent work is installed. Prior to any coring or cutting verify all locations of same with the General Contractor. All cutting and coring is to be performed in accordance with approved coordination drawings. All cutting or coring of structural must receive approval of the Architect prior to proceeding.
- E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

- F. Patching of surfaces shall be by the trade responsible for the surface penetrated.
- G. Refer to related architectural sections including Section 017300 for additional reference.

#### 1.28 COMMISSIONING

- A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 019113 – Building Commissioning Requirements and Section 260800 - Commissioning of Electrical Systems.
- B. Complete installation and startup checks and functional tests according to Section 019113 –Building Commissioning Requirements, Section 260800 - Commissioning of Electrical Systems and manufacturers written instructions.
- C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the start up procedure.
- D. Verify that equipment is installed and commissioned as per requirements of section 019113 and manufacturers written instructions/requirements.

#### 1.29 SUSTAINABLE DESIGN

##### A. SUMMARY

1. The Owner has established that this Project shall minimize the detrimental impacts on Indoor Air Quality (IAQ) resulting from construction activities. Factors that negatively impact indoor air, such as the use of adhesives, sealants, paints and coatings which exceed the minimum levels detailed in Division 01 shall not be permitted.

##### B. REFERENCE STANDARDS

1. SMACNA IAQ: Guidelines for Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3): The Steel Metal and Air Conditioner National Contractors Association.
2. ANSI / ASHRAE 52.2-1999, "Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size".
3. United States Environmental Protection Agency, "Compendium of Methods for the Determination of Air Pollutants in Indoor Air"
4. The United States Green Building Council "Green Building Design and Construction" 2009 Edition

##### C. LEED FOCUS MATERIALS

1. LEED Focus Materials for Divisions 26
2. VOC Products
3. Composite Wood and assemblies containing composite wood
4. Solid wood products and assemblies containing solid wood
5. Lamps that contain mercury (fluorescent; metal halide; mercury vapor)

D. LEED ACTION SUBMITTALS

1. Refer to Section 018113, Sustainable Requirements Summary and Section 018111, LEED V4 for Schools Project Checklist, for detailed descriptions of the submittal documents listed below.
2. LEED Reporting Form (LRF): Submit a completed LRF for the materials included in Sections from Divisions 26 per LEED Reporting Form. Provide only the following information:
  - a. The Volatile Organic Compound (VOC) content for all field-applied interior adhesives, sealants, paints and coatings used.
  - b. Material Costs for all Wood Based Materials (solid wood and Composite Wood).
  - c. If the VOC Budget Method has been selected as the LEED compliance path for Credits EQc4.1 and EQc4.2 provide the Material Costs and VOC Volumes used for applicable adhesives, sealants, paints and coatings.
3. Validation: Provide validation according to the Action Submittals requirements of Section 018113 "Sustainable Requirements Summary" and Section 018111 "LEED V4 for Schools Project Checklist".
  - a. VOC Content
  - b. FSC Certified Wood:
  - c. Composite Wood
  - d. Laminating Adhesives
  - e. Low Mercury Lamps
4. Submittal Package: LEED submittal information shall be assembled into 1 package per Section or sub-contractor. Incomplete or inaccurate submittals may be used as the basis for rejecting the submitted products or assemblies.

E. LEED QUALITY ASSURANCE

1. Field-applied adhesives, sealants, paints and coatings used for interior applications which meet the volatile organic compound (VOC) and chemical component limitations defined in Section "Volatile Organic Compound Limits". This includes products both specified and products not specified but required to complete the work of this section.
2. Composite Wood products that:
  - a. Do not contain added urea-formaldehyde resins.
  - b. Do not use laminating adhesive containing urea-formaldehyde
3. Wood Based Products (solid wood and composite wood) that are certified by the Forrest Stewardship Council (FSC).
4. Mercury-containing lamps with less than 70 picograms per lumen hour of mercury content.

F. INDOOR AIR QUALITY MANAGEMENT

1. Carry out indoor air quality management measures and activities as required in Section 018119 – Construction Indoor Air Quality Management.

G. CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

1. Carry out construction waste management and disposal measures and activities as required in Section 017419 –Construction Waste Mgmt and Disposal.

1.30 TRADE RESPONSIBILITY COORDINATION MATRIX

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring	Notes
Smoke Detectors (Area type)	26 00 10	26 00 10	26 00 10	23 00 00 (ATC)	26 00 10	
Smoke Detectors (Duct mounted)	26 00 10	23 00 00	26 00 10	23 00 00 (ATC)	26 00 10	
Smoke & Fire/Smoke Dampers	23 00 00	23 00 00	N/A	N/A	N/A	
Smoke & Fire/Smoke Damper Actuators	23 00 00	23 00 00	26 00 10 & 23 00 00 (ATC)	23 00 00 (ATC)	26 00 10	2
Fire Dampers	23 00 00	23 00 00	N/A	N/A	N/A	
VAV Boxes	23 00 00	23 00 00	26 00 10	23 00 00 (ATC)	N/A	2
VAV Box Damper Actuator	23 00 00 (ATC)	Box Mfr	23 00 00 (ATC)	23 00 00 (ATC)	N/A	2
VAV Box DDC Controller	23 00 00 (ATC)	Box Mfr	23 00 00 (ATC)	23 00 00 (ATC)	N/A	2
Hydronic Control Valves	23 00 00 (ATC)	23 00 00	N/A	23 00 00 (ATC)	N/A	1
Hydronic Control Valve Actuator	23 00 00 (ATC)	23 00 00 (ATC)	23 00 00 (ATC)	23 00 00 (ATC)	N/A	1
Sheet Metal Damper	23 00 00	23 00 00	N/A	N/A	N/A	1, 7
Sheet Metal Damper Actuators	23 00 00 (ATC)	23 00 00 (ATC)	23 00 00 (ATC)	23 00 00 (ATC)	N/A	1, 7
Natural Gas Energy Meters	23 00 00 (ATC)	22 00 00	26 00 10 & 23 00 00 (ATC)	23 00 00 (ATC)	N/A	3



Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring	Notes
Electrical Energy Meters	26 00 10	26 00 10	26 00 10 & 23 00 00 (ATC)	23 00 00 (ATC)	N/A	3
Domestic Water Meters	23 00 00 (ATC)	22 00 00	26 00 10 & 23 00 00 (ATC)	23 00 00 (ATC)	N/A	3
HVAC Hydronic Energy Meters	23 00 00	23 00 00 (ATC)	26 00 10 & 23 00 00 (ATC)	23 00 00 (ATC)	N/A	3
Airflow Measuring Stations	AHU Manufacturer	AHU Manufacturer	N/A	23 00 00 (ATC)	N/A	
DDC Panels	23 00 00 (ATC)	23 00 00 (ATC)	26 00 10 & 23 00 00 (ATC)	23 00 00 (ATC)	N/A	4, 8
VFDs at RTU & MAU	230000	230000 (ATC)	26 00 00	230000 (ATC)	N/A	
VFDs at EFs (except Kitchen EF), Pumps & AHUs	26 00 00	26 00 00	26 00 00	23 00 00 (ATC)	N/A	
VFDs at EFs (except Kitchen EF), Pumps & AHUs	26 00 00	26 00 00	26 00 00	23 00 00 (ATC)	N/A	
Elevator Hoistway Vent Damper	23 00 00	23 00 00	N/A	N/A	N/A	
Elevator Hoistway Vent Damper Actuator	23 00 00 (ATC)	23 00 00 (ATC)	23 00 00 (ATC)	23 00 00 (ATC)	26 00 10	
Boiler/DHW/Generator Breeching	22 00 00	22 00 00	N/A	N/A	N/A	5
Kitchen Emergency Gas Valve	22 00 00	22 00 00	26 00 10	26 00 10	26 00 10	
Kitchen Energy Management System	Food Service Contractor	Food Service Contractor	26 00 10	23 00 00 (ATC)	26 00 10	
Rooftop Mechanical Plant	230000	230000	26 00 10	230923	26 00 10	9

Notes:

1. Division 23 00 00 and Division 23 00 00 (ATC) Contractors shall fully coordinate all airflow damper and hydronic valves sizes and quantities.
2. Smoke Damper and VAV Box power wiring shall be provided by Division 26 00 10 to junction box locations shown on electrical drawings; Division 23 00 00 (ATC) Contractor shall provide final power wiring from junction box to end device location.

3. Division 26 00 10 Contractor shall provide all line-voltage power wiring required for meters; Division 23 00 00 (ATC) Contractor shall provide all low-voltage power wiring required for meters.
4. Division 26 00 10 shall provide power at main DDC Panel. Division 23 00 00 (ATC) shall provide power to all other DDC Panels.
5. Boiler and domestic hot water heater flue exhaust breeching and combustion air intake ductwork shall be provided by the mechanical plant and enclosure manufacturer.
6. VFDs for HVAC pumps located within rooftop mechanical plant enclosure shall be provided by rooftop mechanical plant and enclosure manufacturer.
7. Sheetmetal dampers and actuators, required for rooftop mechanical plant (RMPE) and enclosure shall be provided by RMPE manufacturer.
8. DDC panel required for rooftop mechanical plant and enclosure (RMPE) shall be provided by RMPE manufacturer.
9. Division 230000 to field install pipe and duct insulation and all mechanical equipment identification. Division 220000 to field install all piping and equipment insulation and identification.

#### 1.31 ALTERNATES

- A. Refer to Section 012300 for complete description of Alternates affecting this section.

### **PART 2 -PRODUCTS**

#### 2.1 GENERAL

- A. Product specifications are written in such a manner so as to specify what materials may be used in a particular location or application and therefore do not indicate what is not acceptable or suitable for a particular location or application. As an example: non-metallic sheathed cable is not specified; therefore, it is not acceptable.
- B. For purpose of establishing a standard of quality and not for purpose of limiting competition, the basis of this Specification is upon specified models and types of equipment and materials, as manufactured by specified manufacturers.
- C. In all cases, standard cataloged materials and systems have been selected. Materials such as lighting fixtures specially manufactured for this particular project and not part of a manufacturers' standard product line will not be acceptable. In the case of systems, the system components shall be from a single source regularly engaged in supplying such systems. A proposed system made up of a collection of various manufacturers' products will be unacceptable.

- D. Where Specifications list manufacturers' names and/or "Or Equal", other manufacturers' equipment will be considered if equipment meets Specification requirements and has all features of the specified items as are considered essential by Architect (and/or Engineer). In all cases the Architect (and/or Engineer) decision shall be final and binding. No exceptions.
- E. All material shall be new and shall be UL listed.

## 2.2 RACEWAYS AND FITTINGS

### A. Raceways - General:

1. No raceway shall be used smaller than  $\frac{3}{4}$  in. diameter and shall have no more than four 90° bends in any one run, and where necessary, pull boxes shall be provided. Only rigid metal conduit or intermediate metal conduit is allowed for slab work. Cable systems, if allowed to be used by other sections of this specification, shall not be used exposed or in slabs, whether listed by "UL" for such use or not.
2. Rigid metal conduit conforming to, and installed in accordance with, Article 344 shall be heavy wall zinc coated steel conforming to American Standard Specification C80-1 and may be used for service work, exterior work, slab work, and below grade level slab, wet locations, and in mechanical rooms for drops down to equipment from elevations below eight feet and also where raceway may be subject to mechanical damage.
3. Intermediate metal conduit conforming to, and installed in accordance with, Article 342, may be used for all applications where rigid metal conduit is allowed by these specifications.
4. Electrical Metallic Tubing (EMT), conforming to, and installed in accordance with, Article 358 shall be zinc coated steel, conforming to industry standards, may be used in masonry block walls, stud partitions, above furred ceilings, where exposed but not subject to mechanical damage, and may be used for fire alarm work.
5. Surface metal raceways conforming to, and installed in accordance with, Article 386 may be used only where raceways cannot be run concealed, and then, if only specifically approved.
6. Flexible metal conduit shall be used for final connections to recessed lighting fixtures from above ceiling junction boxes and for final flexible connections to motors and other rotating or vibrating equipment. Liquid tight flexible metal conduit shall be used for the above connections which are located in moist locations. All flexible connections shall include an insulated grounding conductor.
7. Rigid non-metallic conduit may be used for underground electric and telephone services outside the foundation wall and also below slab and shall be polyvinyl chloride (PVC) schedule 40, 90 deg. C. Rigid metal conduits shall be used thru-foundation walls and thru-slab. Below slab conduits do not require concrete encasement.

8. PVC Schedule 40 may be used for below slab circuits within building confines. Below slab rigid non-metallic conduits do not require concrete encasement. Rigid non-metallic conduits may be used for below slab feeders and branch circuits, but shall not be used in slabs, nor for elbows which penetrate slabs. Raceways and fittings shall be produced by same manufacturer.
9. PVC schedule 40 may also be used for underground branch circuits outside the foundation wall.
10. PVC schedule 80 conduit will be used as indicated on Electrical Site Plan, and as required by code.
11. Acceptable manufacturers:
  - a. Pittsburgh Standard Conduit Company
  - b. Republic Steel and Tube
  - c. Youngstown Sheet and Tube Company
  - d. Carlon
  - e. Or equal
12. Fittings:
  - a. Provide insulated bushings on all raceways 1 inch diameter or larger.
  - b. Manufacturer's standard fittings shall be used for raceway supports.
  - c. Expansion Fittings: Expansion fittings shall be used where structural and concrete expansion joints occur and shall include a ground strap. Bond separate buildings in accordance with code.
  - d. Couplings for rigid metal and intermediate metal conduit shall be threaded type.
  - e. Threadless fittings for EMT shall be watertight compression type or set-screw type (dry-locations). All fittings shall be concrete tight. No diecast fittings allowed except for raceways larger than 1 inch diameter.
  - f. Cable supports in vertical raceways shall be of the split wedge type. Armored cable supports for vertical runs to be of wire mesh basket design.
  - g. Wall entrance seals shall be equal to O.Z. Gedney type "WSK".
  - h. Couplings, elbows and other fittings used with rigid nonmetallic conduit shall be of the solvent cemented type to secure a waterproof installation.
    - 1) Acceptable manufacturers:
      - a) O.Z.
      - b) Crouse Hinds
      - c) Appleton
      - d) EFCOR
      - e) Steel City
      - f) Or equal

B. Outlets, Pull and Junction Boxes:

1. Outlets:

- a. Each outlet in wiring or raceway systems shall be provided with an outlet box to suit conditions encountered. Boxes installed in normally wet locations or surface mounted shall be of the cast-metal type having hubs. Concealed boxes shall be cadmium plated or zinc coated sheet metal type. Old work boxes with Madison clamps not allowed in new construction. Thru the wall boxes are not permitted.
- b. Each box shall have sufficient volume to accommodate number of conductors in accordance with requirements of Code. Boxes shall not be less than 1-1/2 in. deep unless shallower boxes are required by structural conditions and are specifically approved by Architect. Ceiling and bracket outlet boxes shall not be less than 4 in. octagonal except that smaller boxes may be used where required by particular fixture to be installed. Flush or recessed fixtures shall be provided with separate junction boxes when required by fixture terminal temperature requirements. Switch and receptacle boxes shall be 4 in. square or of comparable volume.
- c. Far side box supports shall be Caddy J-1A.
- d. Acceptable manufacturers:
  - 1) Appleton
  - 2) Crouse Hinds
  - 3) Steel City
  - 4) RACO
  - 5) Or equal

2. Pull and Junction Boxes: Where indicated on plans, and where necessary to terminate, tap off, or redirect multiple raceway runs or to facilitate conductor installation, furnish, and install appropriately designed boxes. Boxes shall be fabricated from code gauge steel assembled with corrosion resistant machine screws. Box size shall be sized per Code.

3. Boxes in moist or wet areas shall be galvanized type. Boxes larger than 4-11/16 inches square shall have hinged covers. Boxes larger than 12 inches in one dimension will be allowed to have screw fastened covers, if a hinged cover would not be capable of being opened a full 90 degrees due to installation location.

- a. Acceptable Manufacturers:
  - 1) Brasch
  - 2) Hoffman
  - 3) Keystone
  - 4) Lee Products Co.
  - 5) McKinstry Inc.
  - 6) Eldon Inc.
  - 7) Or equal

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## 2.3 CONDUCTORS

- A. All conductors shall be a minimum size of #12 AWG except for control wiring and fire alarm wiring where #14 AWG may be used. For all exit sign circuits, normal/emergency and/or emergency only circuits, exterior lighting circuits, and also where distance from panelboard to first outlet exceeds 80 ft. at 120 volts and 150 ft. at 277 volts, #10 AWG shall be minimum size wire allowed. All feeder and branch circuit conductor shall be color coded as follows:
- |    |                    |         |                         |
|----|--------------------|---------|-------------------------|
| 1. | 208Y/120V          | Phase A | Black                   |
| 2. | 208Y/120V          | Phase B | Red                     |
| 3. | 208Y/120V          | Phase C | Blue                    |
| 4. | 480Y/277V          | Phase A | Brown                   |
| 5. | 480Y/277V          | Phase B | Orange                  |
| 6. | 480Y/277V          | Phase C | Yellow                  |
| 7. | Grounded Conductor |         |                         |
|    |                    | 120/208 | White                   |
|    |                    | 277/480 | Grey                    |
| 8. | Equipment Ground   |         |                         |
|    |                    | 120/208 | Green                   |
|    |                    | 277/480 | Green with Yellow Trace |
| 9. | Isolated Ground    | 120/208 | Green with Orange Trace |
- B. All conductors not installed in accordance with color scheme shall be replaced. All conductors larger than #6 AWG must be identified with colored tape.
- C. Connections throughout the entire job shall be made with solderless type devices.
1. For #10 AWG and smaller: spring type.
  2. For #8 AWG and larger: circumferential compression type.
  3. Acceptable manufacturers:
  4. 3M "Scotchlock"
    - a. IDEAL "Wingnut"
    - b. BURNDY
    - c. MAC
    - d. Or equal
  5. Any splices made up in ground mounted pull boxes shall be resin cast waterproof type or waterproof pressure type, as manufactured by King Technology, St. Louis, MO.
- D. Conductors shall be copper, soft drawn, and annealed of 98 percent conductivity. Conductors larger than #10 AWG shall be stranded; #10 AWG and smaller shall be solid. Conductors shall be insulated for 600 volts and be of following types:
1. All conductors shall have heat/moisture resistant thermoplastic insulation type THHN/THWN (75 degrees C) except as follows:
    - a. In sizes #1 AWG and larger: Crosslinked polyethylene insulation type XHHW (75 degrees C – 90 degrees C) may be used.

- b. Fire alarm system conductors shall be #14 AWG, type THHN, solid. Color coding of fire alarm conductors shall be in accordance with fire codes.
  - c. Fixture whips #16AWG type "SF".
- E. Stranded conductors for all wiring systems except fire alarm will be allowed if installed and terminated as specified under Execution Section.
- F. Mineral-Insulated Metal-Sheathed Fire-Resistive Cables (Type MI) - Cables shall consist of a factory assembly of one or more solid copper conductors insulated with highly-compressed magnesium oxide and enclosed in a seamless, liquid-and-gas-tight continuous copper sheath. Cables shall be rated for 600 volts and less. Cables shall comply with Article 332 of the National Electrical Code. Cables shall be classified by Underwriters Laboratories, Inc. as having a 2-hour fire resistive rating. Cable terminations shall be made with UL listed mineral-insulated cable fittings. Approved Manufacturer - Pyrotenax USA, Inc. or approved equal.
- G. Type MC Cable may be used for concealed branch circuits and fire alarm in hollow spaces where allowed by code if installed and terminated as specified under Execution Section. Armor shall be galvanized steel and shall be UL listed for 2 hour fire wall penetration. Light steel armor is acceptable. Fire alarm MC cable armor shall be red.
- H. Acceptable manufacturers:
- 1. AFC Cable Systems
  - 2. Cornish
  - 3. Crescent
  - 4. General Cable
  - 5. Okonite
  - 6. Or equal

## 2.4 ACCESS PANELS

- A. Refer to section 083100 – ACCESS DOORS AND PANELS for requirements.
- B. Provide access panels for access to concealed junction boxes and to other concealed parts of system that require accessibility for operation and maintenance. In general, electrical work shall be laid out so access panels are not required. Provide fire rated panels for rated partitions, shafts, etc.

## 2.5 SLEEVES, INSERTS, AND OPENINGS

- A. Sleeves: Provide sleeves of proper sizes for all openings required in concrete floors and walls. Sleeves passing through floors shall be set with top of sleeve 1 in. above finished floor. Core drilling will also be acceptable if in accordance with any structural standards. Any unsleeved openings shall be waterproofed.
- B. Inserts: Provide inserts or other anchoring devices in concrete and masonry construction to support raceways and equipment.
- C. Openings: Where an opening is required in concrete slabs to allow passage of a multitude of raceways, give adequate notice to General Contractor.

- D. Acceptable Manufacturers:
  - 1. Specified Technologies Inc.
  - 2. Thomas & Betts
  - 3. International Protective Coatings Corp.
  - 4. 3M Fire Protection Products
  - 5. Dow Corning
  - 6. Or equal

## 2.6 FLOOR OUTLETS (FLUSH TYPE)

- A. Section includes flush floor boxes equal to Wiremold RFB Series. Provide appropriate floor box model that meets the intent of what is shown on the drawings.
- B. Quality Assurance
  - 1. Electrical Raceways and Components: Comply with requirements of applicable local codes, NEC, UL, and NEMA Standards pertaining to raceways and components. Listed and labeled in accordance with NFPA 70, Article 100.
- C. Floor Boxes
  - 1. RFB4 and RFB4-4DB Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 12-3/4" L x 10" W x 3-7/16" H [324mm x 254mm x 87mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The RFB4 Series Box shall permit tunneling from end power compartment to end power compartment. The RFB4-4DB Series Box shall permit tunneling from adjacent or opposite compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 16.4 cu in [269cu cm], one (1) compartment shall have a minimum capacity of 32.3 cu in [529cu cm], and one (1) compartment shall have a minimum capacity of 50 cu in [820cu cm]. Four (4) compartments shall have a minimum of two (2) inches of space behind the device plates. The box shall include the following number of conduit knockouts: one (1) 1/2-inch [12.7mm], three (3) 1-inch [25mm], six (6) 3/4-inch [19.1mm], and six (6) 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [47.7mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.



2. RFB4-CI-1 and RFB4-CI-NA Series Floor Boxes: Manufactured from cast-iron and approved for use on grade and above grade floors. The box shall be 14-1/2" L x 11-7/8" W x 3-7/16" H [368mm x 302mm x 87mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles and/or communication services. The box shall permit tunneling from adjacent or opposite compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 27 cu in [443cu cm], and two (2) compartments shall have a minimum wiring capacity of 36 cu in [590cu cm]. Four (4) compartments shall have a minimum of two (2) inches of space behind the device plates. The box shall include the following number of conduit hubs: four (4) 1-inch [25mm] and four (4) 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [48mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
3. RFB4-SS Series Floor Boxes: Manufactured from stamped-steel and approved for use on above grade floors. The box shall be 13-5/8" L x 10" W x 2-7/16" H [346mm x 254mm x 62mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 15.7 cu in [257cu cm] and two (2) compartments shall have a minimum wiring capacity of 31.2 cu in [511cu cm]. Four (4) compartments shall have a minimum of two (2) inches of space behind the device plates. The box shall contain the following number of conduit knockouts: two (2) 1/2-inch [12.7mm], six (6) 3/4-inch [19.1mm], and eight (8) 1-inch [25mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [48mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
4. RFB4E Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 13-1/8" W x 4-1/16" H [333mm x 333mm x 103mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The box shall permit feed through removable barriers from adjacent compartments. Four (4) compartments shall have a minimum wiring capacity of 75 cu in [1230cu cm]. Four (4) compartments shall have a minimum of 3-1/2 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: six 3/4-inch [19.1mm], ten (10) 1-inch [25mm], and eight (8) 1-1/4-inch [32mm]. The box shall have two removable knockout plates that can be replaced with a 2-inch trade size conduit hub (2HUB). The box shall be fully adjustable, providing a maximum of 2-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets

- and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
5. RFB4E-OG Series Floor Boxes: Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 13-1/8" W x 4-1/16" H [333mm x 333mm x 103mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The box shall permit feed through removable barriers from adjacent compartments. Four (4) compartments shall have a minimum wiring capacity of 75 cu in [1230cu cm]. Four (4) compartments shall have a minimum of 3-1/2 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: six 3/4-inch [19.1mm], ten (10) 1-inch [25mm], and eight (8) 1-1/4-inch [32mm]. The box shall have two removable knockout plates that can be replaced with a 2-inch trade size conduit hub (2HUB). The box shall be fully adjustable, providing a maximum of 2-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
  6. RFB6 Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 3-1/4" H [333mm x 317mm x 83mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
  7. FB6-OG Series Floor Boxes: Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 3-1/4" H [333mm x 317mm x 83mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of

space behind the device plates and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment.

The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

8. RFB6E Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 4" H [333mm x 317mm x 102mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments through 1-1/4-inch grommet openings. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
9. RFB6E-OG Series Floor Boxes: Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 4" H [333mm x 317mm x 102mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates, and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment.

The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics

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workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

D. Activation Covers

1. FloorPort FPCT, FPBT, and FPFFT Series Covers: Manufactured of die-cast aluminum or die-cast zinc, and available in brushed aluminum finish and powder-coated paint finishes (black, gray, bronze, nickel and brass). Activation covers shall be available in flanged and flangeless versions. Covers shall be available with options for tile or carpet inserts, or flush covers. The cover's hinge shall allow for the cover to open 180 degrees. The furniture feed covers shall come equipped with one (1) 1-inch trade size screw plug opening and one (1) combination 1-1/4-inch and 2-inch trade size screw plug.
  - a. Flanged covers shall be 7-3/4" L x 6-9/16" W [197mm x 167mm].
  - b. Flangeless covers shall be 6-3/4" L x 5-9/16" W [171mm x 142mm].
2. 6CT, 6CTC, 6CFFTC, 8CTC, and 8CT Series Covers: Manufactured of die-cast aluminum alloy and available in powder-coated gray, black, brass, nickel or bronze finish. The covers shall be available in carpet and tile versions. Provide covers with two (2) gaskets (one (1) for carpet and one (1) for tile) to go under the trim flange to maintain scrub water tightness. The activation cover for the 8CTC and 8CT series shall be 9-1/4-inch [235mm] in diameter. The activation cover for the 6CT and 6CTC series shall be 7-1/4-inch [184mm] in diameter and the activation cover for the 6CFFTC series shall be 7-3/4-inch [197mm] in diameter. The carpet covers shall be surface mounted and the tile covers shall be flush with the finished floor covering. The covers shall have spring loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible.
3. The covers shall have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.

E. Communication Modules Mounting Accessories

1. The floor box manufacturer shall provide a complete line of faceplates and bezels to facilitate mounting of UTP, STP (150 ohm), fiber optic, coaxial, and communication devices. The box shall provide a series of device mounting plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, and other open system devices.

F. Installation

1. Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
2. Mechanical Security: Raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.
3. Accessories: Provide accessories as required for a complete installation, including insulated bushings and inserts where required by manufacturer.
4. Unused Openings: Close unused box openings using manufacturer's recommended accessories.

5. Provide a minimum concrete pour depth of 3-7/16-inch [87mm] plus 1/16-inch [1.6mm] above the top of the box for the RFB4, RFB4-4DB, RFB2, and the RFB2-OG Series Boxes; 2-7/16-inch [62mm] plus 1/16-inch [1.6mm] for the RFB4-SS and RFB2-SS Series Boxes; and 3-7/16-inch [87mm] plus 13/16-inch [21mm] above the top of the box for the RFB4-CI-1, RFB6, and RFB6-OG Series Boxes; and 4-1/16-inch [103mm] above the top of the RFB4E and RFB4E-OG Series Boxes; and 4-inch [102mm] above the top of the RFB6E and RFB6E-OG Series Boxes. Provide the box with four (4) locations to accommodate leveling for pre-concrete pour adjustment and include four (4) leveling screws for the pre-pour adjustment.
- G. Poke-Through Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell.
    - b. Pass & Seymour.
    - c. Thomas & Betts Corporation.
    - d. Wiremold
  2. Poke-Thru Assembly
    - a. Floor Fitting
      - 1) The floor fitting shall consist of an insert and an activation cover. Floor fitting shall accommodate power and communications services in a single unit. Floor fitting shall have one ¾" trade size channel for power and one 2" trade size channel for communication cabling. Floor fitting shall consist of intumescent fire stop material to maintain the fire rating of the floor slab and UL Listed with a fire rating of 1, 1½, & 2 hours in an unprotected reinforced concrete floor or a 1 or 2 hour rating in floors employing steel floor units and concrete topping. The floor fitting shall be suitable in concrete floor thicknesses of 2.5" or greater. The insert shall have 12 installation bars that will hold the poke-thru device in the floor slab without additional fasteners.
    - b. Insert Body
      - 1) The insert body shall allow the devices to be recessed 3.5-inches, or 2.25-inches with the use of 1 ¼" supplied stand-offs. There shall be complete separation of channels allowing for individual separation of power and communications services. There shall be one channel arranged such that communication cables can be conduit protected and connected with a 2-inch trade size openings to accept both rigid and flexible conduit connectors. The inserts shall consist of multiple compartments that allow for up to 2 duplex receptacles that can be wired in configurations including standard receptacles, isolated ground or up to 12 communication ports.

- c. Activation Cover/ Flange Assembly
  - 1) Activation covers and Flange shall be manufactured of die-cast aluminum alloy and be capable of being plated in brushed brass, satin nickel, and bronze finish, lacquer coated brushed aluminum or powder-coated in , black, finishes. Flange shall be suitable for either carpet, tile, terrazzo and wood covered floors. Flange shall include a gasket adhered to the top inside surface to maintain scrub water tightness with sub plates. Flange shall include a gasket for assembly against the floor to maintain scrub water tightness. Cover assembly shall provide a single hinged access doors that rotate 180 degrees flush with flange and incorporate foam gaskets to maintain scrub water tightness by preventing water, dirt, and debris from entering the power and communication compartment. Cover assembly shall feature cable access doors which secure to the underside of the closed cover that allow each cable access door to be opened and closed independently
- d. Communication Modules Mounting Accessories
  - 1) The poke-through manufacture shall have available modular inserts to facilitate mounting UTP (including Category 5, 5e, 6, 6a), STP, fiber optic, coaxial, and data/communications devices. The S1R6 series shall accommodate Extron MAAP or Extron AAP adapter plates. Where indicated provide connectivity outlets and modular inserts by Hubbell or approved equal.

#### H. FURNITURE FEED POKE-THRU DEVICES

- 1. Poke-Through Assemblies:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Hubbell.
    - 2) Pass & Seymour.
    - 3) Thomas & Betts Corporation.
    - 4) Wiremold
- 2. Classification and Use: Furniture feed poke-thru devices shall have been examined and tested by Underwriters Laboratories Inc. to meet UL514A and/or UL514C and Canadian Standard C22.2, No. 18-98 and bear the U.S. and Canadian UL Listing Mark. Furniture poke-thru devices shall also have been tested by Underwriters Laboratories Inc. and Classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. Poke-thru devices are approved for use in recessed and flush floor construction and meet and exceed the UL scrub water exclusion test.
  - a. Devices shall be classified for use in 1-, 1-1/2-, or 2-hour rated, unprotected reinforced concrete floors and 1-, 1-1/2-, or 2-hour rated floors employing unprotected steel floor units and concrete toppings (D900 Series designs), or concrete floors with suspended ceilings. Fire resistive designs with suspended ceilings shall have provisions for accessibility in the ceiling below the poke-thru fittings.
  - b. These devices are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens.

- c. Floor boxes shall be suitable for use in air handling spaces in accordance with Section 300-22(c) of the National Electrical Code.

3. MATERIALS

- a. RC7AFFTC Flush Furniture Feed Poke-Thru Assembly for power: Consists of an insert and activation cover. Overall poke-thru assembly length shall be 16-1/2" [419mm].

- 1) Insert: Insert body shall have the necessary channels to provide complete separation of power and communication services. There shall be one (1) 3/4-inch trade size channel for power and two (2) 1/2-inch trade size channels for communication cabling. The channels shall be arranged such that communication cables can be conduit protected and connected to the insert body using a die-cast zinc conduit connector with two (2) 1/2-inch trade size threaded openings to accept both rigid and flexible conduit connections.

- a) The body will consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain the fire rating of the unit and the floor slab. Insert shall have a spring-steel retaining ring that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of one (1) 3/4-inch trade size conduit stub and one 1-1/2-inch trade size conduit stub that are connected to the insert body. There shall also be a 24.5 cu in [402ml] stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru assembly.

- 2) Activation Cover: The activation cover shall provide three (3) conduit openings to feed modular furniture applications and provide a flush appearance. The activation cover trim flange shall be one-piece and be manufactured of forged aluminum alloy and be capable of being powder coated or plated. Coated finish is to be textured, two-stage epoxy paint in gray or black. Activation cover trim flange shall also be available in a solid brass forging and a die cast brushed aluminum finish. Aluminum and brass finish shall be a brushed finish with a lacquer sealant. The activation cover shall be seven (7) inches [178mm] in diameter. A gasket is attached to the underside of the trim flange assembly to maintain scrub water tightness by preventing water, dirt, and dust from entering the power and communication compartments.

- a) The activation cover insert shall provide one (1) 3/4-inch NPSM threaded opening for power and two (2) 1/2-inch NPSM threaded openings for communication to feed modular furniture workstations. Each activation cover shall also be supplied with one (1) 3/4-inch trade size and two (2) 1/2-inch trade size threaded conduit connectors and one (1) 3/4-inch trade size and one (1) 3/4-inch trade size and two (2) 1/2-inch trade size conduit closure plugs.

- b. RC9AM2TC Furniture Feed Poke-Thru Assembly for data: Consists of an insert and activation cover. Overall poke-thru assembly length shall be 10 inches [254mm].
  - 1) Insert: There shall be one (1) 2-inch trade size channel for all power or all communication cabling. The body will also consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain the fire rating of the unit and the floor slab. Insert shall have a spring-steel retaining ring that will hold the poke-thru device in the floor slab without additional fasteners.
  - 2) Activation Cover: The activation cover shall be manufactured of aluminum die-cast alloy and consist of a trim flange and a hexagonal service head. The activation cover shall be capable of being powder coated or plated. Finish shall be textured, two-stage epoxy paint available in a gray or black finish. A gasket is attached to the underside of the activation cover trim flange to maintain scrub water tightness. Trim flange shall have a combination 1-1/4" - 2" trade size conduit opening and closure plugs. The trim flange shall be seven (7) inches [178mm] in diameter. All power connections must be made in a junction box below (not supplied).

I. Cleaning and Protection

- 1. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
- 2. Protect boxes and fittings until acceptance.

2.7 WIRING DEVICES

- A. Receptacles: Receptacles shall be flush mounted. All standard 20 ampere devices to be of same manufacturer.
  - 1. Acceptable Manufacturers:
    - a. 20 ampere duplex grounding type NEMA 5-20R,
      - 1) Arrowhart 5362-V,
      - 2) Hubbell 5362I,
      - 3) Pass and Seymour 53621,
      - 4) Leviton 5362-I
      - 5) Or equal
    - b. 30 ampere, 250 volt NEMA 14-30R complete with plate,
      - 1) Arrowhart 1257,
      - 2) Hubbell 9350,
      - 3) Pass and Seymour 3853
      - 4) GE 1439-3
      - 5) Or equal
  - 2. All receptacles on switch power shall be designated with such and shall have illuminated LED to indicate power available.



- B. All standard 15 and 20 ampere, 125 and 250 volt non-locking type receptacles located 5'-6" or below within Auditorium, Gymnasium, Pre-schools and elementary school age classrooms, medical clinic areas, dental offices and any other areas that are listed in NEC 406.12 shall be tamper resistant type receptacles whether indicated or not the "T" marking on the drawings.
- C. Switches: 20 ampere,
  - 1. Arrowhart CWD 2221,
  - 2. Hubbell 1221,
  - 3. Pass and Seymour 20AC-2,
  - 4. Leviton 1221.
  - 5. GE 5951,
  - 6. Or equal
  - 7. Prewired devices with pigtails acceptable
- D. Composition material of wiring devices to be nylon with finish selected by Architect. Outlets intended for computer use shall be grey finish.
- E. Coverplates: Painted steel with finish selected by Architect.
  - 1. Provide gaskets on all wiring device plates where devices are on walls separating conditioned and non-conditioned spaces and exterior walls.
- F. Exterior Outlets with Lockable Covers:
  - 1. Provide exterior outlets with lockable covers at all exterior outlet locations. Provide GFCI Circuit Breakers on all branch circuits. Provide in-use weatherproof locking covers.

## 2.8 LIGHTING FIXTURES

- A. General
  - 1. Submit the following in accordance with project submittal procedures:
    - a. Catalog Data: Submit catalog data describing luminaires and drivers. Include data substantiating that materials comply with specified requirements. Arrange data for luminaires in the order of fixture designation.
    - b. Performance Curves/Data:
      - 1) Submit certified photometric data for each type of luminaire.
      - 2) Submit supply-air, return-air, heat-removal, and sound performance data for air handling luminaires.
    - c. Drawings: Submit shop drawings for non-standard luminaires.
    - d. Calculations: Submit as requested to support equal product proposals.
    - e. Warranty: Submit warranties for luminaires and for electronic ballasts.
  - 2. All LED sources, drivers, and controls shall meet the latest utility company incentive requirements. Refer to the latest program requirements documentation and coordinate with the utility company to ensure compliance.

B. Quality Assurance

1. Comply with the National Electrical Code (NEC) and the Massachusetts Building Code (MBC) for components and installation.
2. Provide luminaires listed and labeled by a nationally recognized testing laboratory (NRTL) for the application, installation condition, and the environments in which installed.
3. Use manufacturers that are experienced in manufacturing luminaires, lamps and ballasts similar to those indicated for this Project and have a record of successful in-service performance.
4. Coordinate luminaires, mounting hardware and trim with the ceiling system.

C. LED Assemblies

1. LED luminaires shall conform to UL 1598 and to UL 8250 – Safety Standard for Light-Emitting Diode (LED) Light Sources for Use in Lighting Products.
2. Products shall be lead and mercury free.
3. Photometric characteristics shall be established using IESNA LM-79-08, IESNA Approved Method for the Electrical and Photometric Measurement of Solid-State Lighting Products.
4. Color characteristics of LED luminaires shall be as follows in accordance with ANSI C78.377 – Specifications for the Chromaticity of Solid State Lighting Products.
5. LED and driver cooling system shall be passive and shall resist the buildup of debris.
6. LED luminaire output after 50,000 hours of operation shall be not less than 70 percent of the initial lumen output when determined in accordance with IESNA LM-80-08 – IESNA approved Method for Measuring Lumen Maintenance of LED Lighting Sources.
7. LED source package electrical characteristics:
  - a. Supply voltage: 120 V, 208 V, 240 V, 277 V, or 480 V as indicated on the Drawings. Provide step-down transformers if required to match driver input voltage rating.
  - b. Total harmonic distortion (current): Not more than 10 percent
  - c. Power factor: Not less than 90 percent
  - d. RF interference: Meet FCC 47 CFR Part 15/18
  - e. Transient protection: IEEE C62.41 Class A.
8. All LED Assemblies shall be provided by Osram, Phillips, GE, or equal.

D. Extra Materials

1. Furnish the following extra materials matching products installed. Package with protective covering for storage and identify with labels describing contents.
  - a. Ten percent of single faced exit signs, but no fewer than ten. Include 100' of type MC cable branch circuiting and installation labor.
  - b. Ten percent of double faced exit signs, but no fewer than five. Include 100' of type MC cable branch circuiting and installation labor.

E. Interior General:

1. Furnish interior luminaries that comply with requirements specified below, indicated on the Drawings to meet conditions of installation.
2. Metal parts shall be free from burrs and sharp corners and edges.
3. Metal components shall be formed and supported to prevent sagging and warping.
4. Steel parts shall be finished with manufacturer's standard finish applied over a corrosion-resistant primer. Finish shall be free from runs, streaks, stains, holidays or defects.
5. Doors and frames shall be smooth operating and free from light leakage under operating conditions. Relamping shall be possible without the use of tools. Doors, frames, lenses and diffusers shall be designed to prevent accidental falling during relamping and when secured in the operating position.
6. Luminaires shall have minimum reflecting surface reflectance as follows unless specified otherwise on the Drawings:
  - a. White Surfaces: 85 percent
  - b. Specular Surfaces: 83 percent
  - c. Diffusing Specular Surfaces: 75 percent
7. Lenses, diffusers, covers and globes shall be 100 percent virgin acrylic unless specified otherwise on the Drawings. Lenses shall have 0.125 inch minimum thickness. Lenses for troffers shall be injection molded.
8. Luminaires shall conform to UL 1598 - *Luminaires*. Provide product with damp location listing or wet location listing by installation location.

F. Interior Accessories

1. Provide stud supports, mounting brackets, frames, plaster rings and other accessories required for luminaire installation.
2. Furnish hangers as specified below by conditions of installation:
  - a. Stem hangers shall be made of 1/2-inch steel tubing with 45 degrees swivel ball hanger fitting and ceiling canopy. Finish the same as the luminaire.
  - b. Rod hangers shall be made of 1/4 inch threaded zinc-plated steel rod.
3. Use NRTL-listed T-bar safety clips for lay-in luminaires.

G. Interior Installation

1. Install interior lighting system in accordance with the NEC, manufacturer's installation instructions, approved shop drawings, and NECA National Electrical Installation Standards.
2. Have the manufacturer's installation instructions available at the Project site.
3. Mounting heights specified or indicated on the Drawings are to the bottom of the luminaire for ceiling-mounted fixtures and to the center of the luminaire for wall-mounted fixtures.
4. Where the ceiling forms the protective membrane of a fire resistive assembly, install protective coverings over luminaires in accordance with NRTL requirements.

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5. Install slack safety wires as described below for luminaires in or on suspended ceilings.
    - a. Wire shall be minimum 12 gage galvanized soft annealed steel wire conforming to ASTM A641.
    - b. Attach wire to the building structure directly above the attachment point on the box or luminaire; make trapezes of framing channel material to span obstacles
    - c. Secure wire(s) at each end with not less than three tight turns in 1-1/2 inch.
  6. Support pendant-mounted or cable-supported luminaires directly from the structure above using a 9 gage wire or an approved alternate support without using the ceiling suspension system for direct support.
    - a. Install seismic restraints for pendant-mounted and cable-supported luminaires.
    - b. Pendants, rods, cables, or chains 4 ft or longer shall be braced to prevent swaying using three cables at 120 degrees separation.
  7. Connect luminaires in suspended ceilings using 6 ft. lengths of flexible wiring method arranged accommodate not less than 4 inch of differential seismic movement in any direction.
- H. Interior Quality Control
1. Make electrical connections, clean interiors and exteriors of luminaires, install lamps, energize and test luminaires, inspect interior lighting system, and deliver spare parts in accordance with manufacturer's instructions and NECA National Electrical Installation Standards:
  2. Test electronic dimming ballasts for full range dimming capability.
    - a. Check for visually detectable flicker over the full dimming range.
- I. Exterior - General
1. Furnish exterior luminaires that comply with requirements specified in this Section and in the luminaire schedule on the Drawings.
  2. Luminaire photometric characteristics shall be based on IESNA approved methods for photometric measurements performed by a recognized photometric laboratory.
  3. Luminaire housing shall be primarily metal.
    - a. Metal parts shall be free from burrs and sharp corners and edges.
    - b. Sheet metal components shall be fabricated from corrosion-resistant aluminum, formed and supported to prevent sagging and warping.
    - c. Exposed fasteners shall be stainless steel.
  4. Doors and frames shall be smooth operating and free from light leakage under operating conditions.
    - a. Relamping shall be possible without the use of special tools.
    - b. Doors, frames, lenses and diffusers shall be designed to prevent accidental falling during relamping and when secured in the operating position.
    - c. Door shall be removable for cleaning or replacing lens.

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5. Luminaires shall have minimum reflecting surface reflectance as follows unless scheduled otherwise:
    - a. White surfaces: 85 percent
    - b. Specular surfaces: 83 percent
    - c. Diffusing specular surfaces: 75 percent
  6. Provide lenses, diffusers, covers and globes as scheduled on the Drawings fabricated from materials that are UV stabilized to be resistant to yellowing and other changes due to aging or exposure to heat and ultraviolet radiation.
  7. Doors shall have resilient gaskets that are heat-resistant and aging-resistant to seal and cushion lens and refractor.
- J. Exterior Poles and Accessories
1. Furnish poles and accessories that comply with requirements specified in this Section and the luminaire schedule on the Drawings.
  2. Pole, base, and anchorage shall carry the luminaires, supports, and appurtenances at the indicated height above grade without deflection or whipping.
  3. Mountings, fastenings and other appurtenances shall be fabricated from corrosion-resistant materials that are compatible with poles and luminaires and will not cause galvanic action at contact points. Mountings shall correctly position luminaires to provide scheduled light distribution.
  4. A reinforced access handhole shall be located in the wall of each metal pole.
  5. A welded 1/2 inch grounding lug shall be accessible through the handhole of each metal pole. Grounding connection shall be designed to prevent electrolysis when used with copper ground wire.
  6. Metal poles shall have anchor type bases and galvanized steel anchor bolts and leveling nuts.
  7. Metal poles shall have a metal base cover that covers the entire base plate and anchorage.
  8. Protect painted, anodized, or brushed pole finishes during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.
  9. Aluminum poles shall be fabricated from corrosion resistant aluminum Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys or Alloy 356-T4 for cast alloys.
    - a. Poles shall be square or round, tapered or straight as indicated on the Drawings.
    - b. Aluminum poles over 30 feet tall shall include factory-installed vibration dampers.
    - c. Poles shall be seamless extruded or spun seamless type with minimum 0.188 inch wall thickness.
    - d. Tops of shafts shall be fitted with a round or tapered cover.

- e. Base shall be anchor bolt mounted, made of cast 356-T6 aluminum alloy in accordance with ASTM B 108/B 108M, Standard Specification for Aluminum-Alloy Permanent Mold Castings and shall be machined to receive the lower end of shaft. Joint between shaft and base shall be welded.
  - f. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel.
10. Anchor bolts shall be steel rod having minimum yield strength of 50,000 psi. The top 12 inch of the anchor bolt shall be galvanized in accordance with ASTM A153/A153M.
11. Manufacturers: Subject to compliance with requirements, provide products as scheduled or specified on the Drawings.
12. Fuses and Fuse holders
- a. Furnish fuse overcurrent protection for each pole-mounted luminaire to isolate faulted ballasts from the lighting circuit.
  - b. Use 600 volt, Class CC, time-delay, current-limiting fuses.
  - c. Select fuses rated between 200 percent and 300 percent of the luminaire ballast or driver maximum current.
  - d. Manufacturer: Bussman "LP-CC" or approved equal.
13. Furnish in-line fuse holders for installation in pole hand hole or transformer base.
- a. Use non-breakaway type fuse holders unless breakaway poles are indicated on the Drawings.
  - b. Use breakaway type fuse holders where breakaway poles are indicated on the Drawings.
  - c. Load and line terminal sizes and types shall correspond to line and load conductor sizes and quantities.
  - d. Both breakaway and non-breakaway fuse holders shall have insulating boots.
  - e. Manufacturers: Ferraz Shawmut "FEC" for phase conductor(s), "FEBN" for neutral conductor, or approved equal.

## 2.9 THEATRICAL LIGHTING, DIMMING RACK AND CONTROLS

- A. The Electrical Sub-Contractor, herein also referred to as the EC, shall provide all labor, materials, services, and equipment to set, install, interconnect, and test the dimming and control systems as shown on the drawings and as specified herein. Drawings, specifications, and other related documents shall apply to all work. EC shall provide all Theatrical lighting, dimming racks, controls, curtains and rigging, refer to section 116100.

B. Work of this Section includes, but is not limited to, the following:

1. Installation of wiring devices, back boxes, panels, conduits, wiring, dimmer racks and modules, signal cables, DMX splitters, and architectural processor provided by Division 11, including:

Division of Responsibilities ITEM	Electrical Contractor		Stage Lighting Contractor, Sections 116133, 116191, and 266111	
	Furnish	Install	Furnish	Install
High voltage conduit and wire (Line Voltage)	X	X		
High Voltage wire terminations	X	X		
High voltage wire testing and labeling	X	X		
Stage Emergency Lighting Transfer switch		X	X	
Installation of stage ECR rack and power		X	X	
Conduit for ECR rack low voltage devices	X	X		
Labeling back boxes and conduit	X	X		
Dimming System Low voltage conduit and back boxes	X	X		
Low voltage wire for dimming system		X	X	
Termination of Dimming system low voltage wire			X	X
Dimming System Control wire continuity, testing and labeling			X	X
Low voltage wire for Fire alarms, security or other	X	X		
Conduit, raceways and interconnecting boxes	X	X		
Junction Boxes	X	X		
Provide power feed and termination to Batten Hoists	X	X		
Provide conduit for batten hoist controls	X	X		
Mount Batten hoist control stations		X	X	
Low voltage wire and controls for batten hoists	X	X		
Dimmer Racks or cabinets		X	X	
Provide terminations for all dimmer load circuits	X	X		
Control Devices			X	X
Architectural Control - House lighting back boxes		X	X	
Circuit Distribution Raceways and Boxes		X	X	
Mounting of Stage Circuit Raceways to battens		X	X	X
Lighting Fixture Installation and testing			X	X
Lighting Fixture Focus			X	X
Lighting Initial programming			X	X

2. Coordination with the System Integrator for a complete theatrical dimming system.
3. All power distribution devices, conduit and wire as required in this Section and related Specification Sections listed herein.
4. Provide all disconnects and power feeds as required for dimmer racks

5. Provide continuous liaison with the General Contractor (GC) and other trades during demolition, construction, and coordinate delivery schedules and installation of equipment.
6. The EC shall provide coordination drawings for approval showing all elements of the items in this section in an AutoCAD® file Release 16 or more recent due prior to the installation of any materials on site. This drawing shall be executed using a cross-reference of the appropriate areas of the building as a background supplied by the Architect. Minimum drawings shall include plan and section of pertinent areas noting panels, conduit size, elbows, bends and wiring devices. All elements of this drawing shall be on no more than three layers all prefixed with "-ELEC". All items shall be drawn full size with "color by layer". Hard (paper) and soft (digital) copies of this file shall be requested and used by the Architect and Theatre Consultant.
7. Materials shall be as specified under Division 26 00 10
8. This specification shall be considered as an outline form and other appurtenances that may be required for the efficient and safe operation of the dimming and control systems specified in this section shall be furnished by the EC, the same as if specified herein.
9. All work shall be manufactured and installed in accordance with the latest editions of applicable publications and standards of the following organizations:
  - a. National Electric Code (NEC) and all prevailing local regulations
  - b. Underwriter's Laboratories, Inc. (UL)
  - c. National Electrical MFRS. Association (NEMA)
  - d. Federal Communication Commission (FCC)
  - e. United States Institute of Theater Technology (USITT)
10. The EC shall provide all mounting and mechanical installations and shall verify all mounting conditions.
11. Any materials installed which shall not present an orderly and reasonably neat or workmanlike appearance shall be removed and replaced when so directed by the at the EC's expense.
12. Any quantities, measurements or dimensions listed or shown are for the convenience of the EC in the preparation of his estimate, but will not relieve the EC of his responsibility for the determination of the exact measurements required for a complete job.

C. System Outline

1. The theatrical dimming system consists of wiring devices, both low and line voltage, theatrical dimmer rack, lighting control rack and remote consoles.
2. The DMX 512 control signal shall be generated by various consoles and devices, and shall be connected to the dimmer racks via conduit runs and appropriate low voltage cables specified herein. Access to the DMX network shall be provided via the Lighting Control Rack (LCR).
3. All equipment shall be the coordinated system integrated by the SI in coordination with the EC.



4. The specified dimming and control components are called out in terms of products as manufactured by Electronic Theater Controls, Electronics Diversified, Union Connector and others. This equipment is fully described in the Contract Documents. Complete technical data is also available from the manufacturers. All catalog numbers are those shown on Manufacturer's data sheets and drawings unless otherwise noted.
5. The dimming equipment, wiring devices and control devices shall be set into place and installed by the EC. It shall be the EC's responsibility to run all conduit and wiring for line and low voltage circuits, and make only line voltage terminations at the wiring devices.
6. When the EC is finished, a fully working and tested system will be turned over to the Owner. If mention has been omitted of any items of the work or materials usually furnished for, or necessary to the completion of the electrical work or if there are conflicting points in the specifications and/or drawings, the Architect's attention should be called to such items in sufficient time for a formal addendum to be issued.

D. System Commissioning

1. At no time shall the equipment furnished be energized prior to the SI authorized commissioning
2. The EC shall notify the SI within at least two weeks time for system commissioning.
3. The EC shall confirm in writing that the following conditions have been met prior to scheduling system commissioning.
  - a. Arrangements shall be made for access to all equipment. Scaffolding, lifts or any other OSHA approved method shall be acceptable.
  - b. All dimmer racks shall be installed and wired.
  - c. All control wire shall be installed.
  - d. All distribution equipment shall be completely installed.
  - e. Continuity checks for the entire system shall have been performed and failures remedied.
4. At the time of commissioning the EC shall provide a representative who is has full working knowledge of the system, device placement and job conditions. This representative shall be on-site throughout the commissioning process and shall coordinate with, and aid, the SI to expeditiously commission the system.

E. Inspection and Testing

1. Field Check-out & Final Approvals
  - a. Furnish all equipment and instruments necessary for testing the complete wiring system during the progress of the work as well as after installation. Tests shall be demonstrated to the satisfaction of the Owner. Test the following:
    - 1) All circuits are continuous and free from short circuits
    - 2) All circuits are free from unspecified grounds
    - 3) All circuits are properly connected in accordance with the applicable wiring diagram
    - 4) Voltage drop at each end of the circuit with a 2000 watt load

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- 5) All low voltage circuits complying to industry standards
  2. Final check of House, Work and Stage control system
    - a. All work under this contract, upon completion of installation, shall be demonstrated, tested and adjusted in coordination with the SI and the EC. No part of the system shall be energized before being so checked and the installation approved.
    - b. Make all necessary arrangements for all parties concerned to be present, by scheduling such inspection in a manner acceptable to the Theatre Consultant and give a minimum of 14 days notice.
    - c. Furnish all labor, materials and instruments necessary for this inspection and testing.
  3. Final site visitation by the Theatre Consultant
    - a. When the work on the entire structure has been completed and is ready for final review, a visit will be made by the Theatre Consultant or his duly authorized representative, at which time the SI shall demonstrate that the requirements of the contract as it applies to his work have been carried out and that the system has been adjusted and operates in accordance therewith.
    - b. Any defects shall be repaired at once and the tests re-conducted.

## 2.10 AUTOMATED LIGHTING CONTROL SYSTEM

- A. General: Summary
  1. Section Includes:
    - a. Addressable Networked Light Management System.
- B. References
  1. National Fire Protection Association (NFPA)
  2. cULus Listing/Certification
    - a. Certified as Energy Management Equipment (UL 916)
    - b. Certified as Emergency Lighting Equipment (UL 924)
    - c. Meet Heat and Smoke Release for Air-Handling Spaces (UL 2043)
  3. Federal Communications Commission (FCC) / Industry Canada (IC)
  4. California Energy Commission (CEC)
  5. Local Building Codes
- C. System Description
  1. Lighting Control System includes computer-based software that provides control, configuration, monitoring and reports. System includes the following components:
    - a. Central Control Unit
    - b. System Server
    - c. 0-10V Dimming, Fixed Output Ballasts or 0-10V LED Drivers
    - d. System Field Devices (Input and Output Modules)
    - e. Lighting Control System Software

- f. Lighting Controllers
  - g. Communication Wire
  - h. Occupancy sensors
  - i. Photo sensors
  - j. Lighting control panels
  - k. Interface to audio visual equipment
  - l. Interface to BACnet
  - m. Interface to Tridium Niagara
  - n. Incandescent low-voltage dimming modules
  - o. Tunable white light programming
  - p. Coordination of final lighting programming
  - q. Owner training
- D. Submittals
- 1. Bill of Materials: Complete list of all parts needed to fully install selected system components.
  - 2. Product Data: For each type of product indicated.
  - 3. Shop and Wiring Drawings: Submit shop drawings detailing control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.
  - 4. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
    - a. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
    - b. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
  - 5. Software Operational Documentation:
    - a. Software operating and upgrade manuals.
    - b. Program Software Backup: On compact disc or DVD, complete with data files.
    - c. Prinout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.
  - 6. Installation Instructions: Manufacturer's installation instructions.
  - 7. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
  - 8. Warranty: Copy of applicable warranty.
- E. Quality Assurance

1. Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.
2. Manufacturer Requirements: The manufacturer shall have a minimum of 10 years experience manufacturing networked lighting control systems and shall provide 24/7 telephone support by qualified technicians.
3. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the system provider to ensure proper system operation and maintainability.
4. Performance Requirements: provide all system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.
5. Performance Testing Requirements
  - a. Manufacturer shall 100 percent test all equipment prior to shipment. Sample testing is not acceptable.
6. Code Requirements
  - a. System Control Unit and System Field Devices shall be cULus listed and certified.
  - b. All system components shall be FCC /IC compliant.
  - c. All system components shall be installed in compliance with National Electrical Codes and Canadian Electrical Code.
  - d. Building Codes: All units shall be installed in compliance with applicable, local building codes.
7. ISO Certification: System components shall be manufactured at ISO-9000 certified plants.

F. COORDINATION

1. Coordinate lighting control components to form an integrated interconnection of compatible components.
  - a. Match components and interconnections for optimum performance of lighting control functions.
  - b. Display graphics showing building areas controlled; include the status of lighting controls in each area.

G. Delivery, Storage & Handling

1. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
2. Delivery: Deliver materials in manufacturer's original, unopened, undamaged packaging with intact identification labels.
3. Storage and Protection: Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

H. Warranty

1. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
2. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.
3. Manufacturer's Warranty: All equipment shall be warranted free of defects in materials and workmanship.
  - a. Warranty Period: All system hardware components shall have full warranty (non-prorated) for at least four years and all software components shall carry a warranty of 90 days from date of installation.
  - b. Owner Rights: Manufacturer's warranty is in addition to, not a limitation of, other rights the Owner may have under contract documents, or warranties of third party component manufacturers.

I. Basis of Design Products

1. Controls: ENCELIUM Energy Management System by OSRAM SYLVANIA
2. Sensors: ENCELIUM Sensors by OSRAM SYLVANIA & Hubbell Building Automation, Inc.

J. Acceptable Alternate Manufacturers

1. Controls: Lutron, N-light, Philips, or equal.
2. Sensors: Lutron, Sensor Switch, Watt Stopper, Leviton, Cooper or equal.

K. System Performance Requirements

1. This specification is intended to fully describe all of the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.
2. The lighting control "system" shall include a fully distributed WAN/LAN network of global controller/routers, individually addressable System Field Devices, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system WAN/LAN shall be commissioned by ENCELIUM personnel or other ENCELIUM certified commissioning contractors.
3. The basis of system design shall utilize non-propriety industry standard 0-10V dimming or fixed output ballasts and/or 0-10V LED drivers, occupancy sensors, and daylight sensors.
4. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.

5. Lighting Control Software: The system shall offer two separate levels of lighting control: one personal lighting control for the average building occupant to control and adjust basic lighting functions in their workspace, and two central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.
  - a. Native central control software shall be utilized for energy reporting status and complete programming without the need for any third party hardware or software. Systems that require any third party linked software or graphics shall be unacceptable.
  - b. Software shall provide information on general system settings via mouse click on a floor plan. Left clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.
6. Central Lighting Control:
  - a. Shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user's computer or the lighting control system's main computer. Shall include the navigational features listed below to allow for user's orientation within the controlled space, geographic heading and/or landmarks:
    - 1) Interactive
    - 2) Vector based
    - 3) Zoom
    - 4) Rotate
    - 5) Pan
    - 6) Tilt
  - b. Shall allow building operator to navigate through an entire facility both in two-dimensional and three-dimensional multi-floor view, allowing for fast and easy navigation.
  - c. Three-dimensional view shall exclude walls and other structural features to avoid shadowing and cluttering of the plan view.
  - d. All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don't offer real time feedback are not acceptable.

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- e. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.
    - 1) Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual fixture availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.
  - f. Shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels, Load shedding status, or Lighting energy consumption, Occupancy status in a colorized gradient ("weather" map) type of graphical representation.
  - g. Energy Analysis data shall be exportable in a CSV or similar format.
  - h. Shall allow import of native AutoCAD files.
7. Reports: Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:
- a. Energy consumption broken down by energy management strategy.
  - b. Energy demand broken down by energy management strategy.
  - c. Occupancy data by zone.
  - d. Building wide occupancy status
  - e. Lighting energy consumption in a color gradient ("weather map" type) view
  - f. Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications.
8. Personal Lighting Controls: The Personal Control Software interface shall provide current status and enable each user with the ability to dim and brighten lights, and turn them on and off by individual fixture or zone. The Software shall offer user configurable light scenes, which may be programmed and then selected via the Software. Personal lighting control shall be available in open/private office environments.
9. Daylight Harvesting (Light Regulation Averaging): In a photo sensor-equipped system, the Central Controller Unit shall rationalize changes to light levels when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions where dimming ballasts and/or drivers exist. Areas equipped with fixed output ballasts and/or drivers shall energize when natural light falls below foot-candle levels specified. System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photo sensors required. The System shall operate with multiple users in harmony and not react adversely to manual override inputs.
10. Time Clock Scheduling: The system shall be programmable for scheduling lights on or off via the Lighting Control Software interface.
- a. Support for BACnet Time Schedule Object: This allows the export of Lighting Control time schedules to BACnet devices and vice versa in the event of Lighting Control System's integration with BACnet.

- b. Override: Manual adjustments via lighting controllers or personal control software shall temporarily override off status imposed by time clock schedule.
  - c. Response to Power Failure: In the event of a power failure, the time clock shall execute schedules that would still be in progress had they begun during the power outage.
  - d. Flick Warning: Prior to a scheduled lights-off event or expiry of a temporary override, the system shall provide two short light level drops as a warning to the affected occupants. Flick warning time shall have the ability to be programmed via software between one and five minutes.
11. Load Shed Mode: An automatic load shedding mode shall be available where, when activated through the system, the control unit will reduce its output to a programmable maximum electrical demand load. The system shall not shed more load than required and load shedding priority shall be centrally configurable by control zone or by common uses (i.e., all hallways can be treated as one load shed group), with subsequent load shed priority groupings being utilized until the required defined load has been shed, for either a defined period, or until the demand response input has been removed. Systems that simply select a "load shed scene" whereby there is no guarantee that the defined required load will actually be shed are not acceptable.
12. Emergency Mode: There shall be a mode, when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building of life safety transfer switch, fire alarm control panel, and security system control panel.
13. Addressing: All ballasts and/or drivers shall be centrally addressable, on a per fixture or multiple fixtures/zone basis, through the Central Control Software. The basis of design shall utilize industry standard 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers connected to an Output Module. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of commissioning or reconfiguration.
14. Programmable Task Tuning: Maximum light level programmability shall be available by individual fixture.
15. Unoccupied State: The system shall provide two states when occupancy status is vacant as per an occupancy sensor: lights turn off or lights adjust to configurable (dimmed) light level.
16. Occupied State: The system shall be capable of creating "comfort" or "support" zones to ensure that occupants are not isolated by turning off lights in adjacent areas for occupant comfort and safety, such as a hallway path to exit the premises.
17. The Automated Lighting Control System (ALCS) BACnet Interface shall share the following information with the BACnet enabled Building Automation System and other systems listed below:

<u>Property</u>	<u>BACnet Type</u>	<u>Description</u>
Lighting Load	Analog Value*	Reports the total lighting load of the



		ALS, defined in Watts
Light Zone State	Binary Value*	State of the defined lighting zone - ON or OFF
Light Zone Dimming	Analog Value*	Light output level of the defined lighting zone, from 100 percent (maximum light output) to 0 percent (minimum light output)
Emergency System State	Binary Input	State of the emergency alarm system: alarm activated or alarm not activated
Fire Alarm State	Binary Input	State of the fire alarm system: alarm activated or alarm not activated
Security System State	Binary Input	State of security alarm system: alarm activated or alarm not activated
Occupancy State	Binary Output	State of the defined occupancy sensor – occupancy detected or not detected
Sheddable Load	Analog Output	Reports the total lighting load available for load reduction according to ALS, defined in Watts
Shed Status	Analog Output	Reports the total current load reduction achieved according to ALS defined prioritization, defined in Watts

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Shed Request	Analog Input	Requested total amount of load reduction, defined in Watts or as a percentage of sheddable load
Sheddable Load (Group)	Analog Output	(As above, unprioritized for the selected group)
Shed Status (Group)	Analog Output	(As above, unprioritized for the selected group)
Shed Request (Group)	Analog Input	(As above, unprioritized for the selected group)

18. LAN Operations: System shall be capable of operating independent of building's existing network infrastructure if desired and shall not rely on tenant supplied PCs for operation. Network infrastructure shall only be utilized for Personal Control Software.
19. Firewall Security: Firewall technology shall be utilized to separate tenants from the lighting control network.
20. Lamp Burn In: The system software shall not permit dimming of new lamps prior to completion of lamp manufacturer 100 hour recommended accumulated operation at full brightness.
21. Re-configurability: The assignment of individual fixtures to zones shall be centrally configurable by Central Control Software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, and ceiling tiles. shall not be required.
22. Automatic Control Parameters: Occupancy sensor time delays shall be configurable through software. Light level sensor parameters shall be configurable through software.
23. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight savings time and shall provide weekly routine and annual holiday scheduling.
24. Contact closure input: System shall be capable of receiving a momentary and sustained contact closure input from third party sources to control lighting zones.

25. The light management system shall interface digitally with the building automation system via BACnet/IP and Tridium Niagara AX interface. The lighting control system shall communicate the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) over this connection allowing the building automation system to utilize lighting control system input devices such as occupancy sensors to determine if mechanical control zones are occupied for climate adjustments.
26. The system software shall provide a web based energy dashboard to show real time energy savings data and carbon footprint reductions.
27. Migration Plan to Control LED Fixtures
  - a. System shall be capable of migrating from the control of 0-10V Ballasts to 0-10V LED Drivers utilizing the same Output Modules without the need to change control hardware.

L. Lighting Controllers

1. Description: The system shall include separate lighting controllers for each of the listed functionalities and at minimum meet listed electromagnetic, mechanical, electrical and data specifications:
  - a. Software configurable lighting controller that provides on/off switching and dimming control for up to three lighting zones/scenes per controller or more with allowable multi-gang configurations. Status is indicated by an LED display to indicate function, scene or zone. Allows manual override of the time schedule.
  - b. Manual dimming and/or switching lighting controller that provides local on/off and dimming control over at least three lighting zones. Allows manual dimming of light levels and override of the time schedule.
  - c. Scenes in the central control software shall be synchronized with the buttons on the lighting controller.
  - d. Lighting controllers shall fit in a standard Decorator style wall plate and may be ganged together.
2. General
  - a. Addressing: All controllers shall be individually addressable & reconfigurable via Central Control Software.
  - b. Shall provide local on/off or dimming control over lighting zones
  - c. Shall utilizing a standard single-gang or multi-gang form factor
  - d. Shall have a terminal block that connects to lighting system with 18 AWG, polarity independent, CMP rated and low voltage wire
  - e. Shall be manufactured with push-in wire receptacles
  - f. LED's: All controllers shall feature LED's to indicate light on and light off status.
  - g. Color: All controllers shall meet NEMA WD1 color specifications.
  - h. Style: All controllers shall feature Decorator styling wall plates.
  - i. Lighting scenes reconfigure automatically based on scene changes from personal control software.

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- j. Industrial lighting controllers shall also be available for damp location applications.
  - k. Shall comply or exceed the following electromagnetic requirements:
    - 1) EN 61000-4-2
    - 2) EN 61000-4-4
    - 3) EN 61000-4-5
    - 4) FCC Part 15/ICES-003
  - 3. Mechanical Specifications:
    - a. Dimensions: Shall meet NEMA WD-6 spec.
    - b. Maximum Operating Ambient Temperature: 60 deg C.
    - c. Mounts in standard size wall box suitable for multi gang installation or alternative of Low Voltage mounting bracket.
    - d. Suitable for use with Decorator style wall plates.
  - 4. Electrical Specifications:
    - a. Class 2 Low Voltage device.
    - b. Power through interconnected 18 AWG cable with 2-pin header
  - 5. Data Specifications:
    - a. Class 2 communication bus that uses prefabricated 18 AWG cable.
- M. System Field Devices (Input and Output Modules)
- 1. General: Input Modules provide a common interface to low voltage occupancy sensors and photo sensors while Output Modules provide a common interface to 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers and analog dimming devices such as incandescent low-voltage dimming modules. These modules automatically self-address and detect the type of devices they are connected to (i.e., photo sensor, occupancy sensor, 0-10V ballast, 0-10V LED drivers or incandescent dimming module) and establish two-way communication between the system Control Unit (CU) and themselves. These individually addressable modules enable each lighting component to be independently controlled and configured to best meet the needs of the facility.
    - a. Addressing: System Field Devices shall be individually addressable via Central Control Software.
    - b. System shall automatically address individual nodes during system commissioning thus eliminating the need to pre-address devices or record serial numbers during installation.
    - c. Modules shall at minimum meet the listed general, mechanical and environmental specifications set at below.
  - 2. Provide Wireless site lighting control (WSLC) module for all site lighting unless specifically noted on the electrical site plan.
  - 3. Air Gap Off
    - a. Definition: Air Gap Off shall refer to the physical disconnection of AC power to the ballast or driver when "OFF" is selected either automatically or manually, thus ensuring maximum energy savings by eliminating off-state phantom power losses as well as ensuring that no potentially lethal high-voltage is present at the ballast or driver when the lights appear to be off (for life-safety reasons).

- b. Provisions: Provide an air-gap off relay for each control zone in the system. Where each fixture is to be controlled (dimmed and/or switched) independently, provide one relay per fixture. Where multiple fixtures are to be controlled (dimmed and/or switched), provide one relay per control zone, sized to handle both the inrush current as well as the maximum connected load, at the specified voltage.
- 4. General Specifications:
    - a. Shall supply 12VDC (up to 24VDC) to sensors.
    - b. Shall have 2 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting Class 2 communication bus that supplies 24 VDC.
    - c. Two models, one rated for regular indoor use and other for use in damp locations such as basements, cold storage areas. shall be available.
    - d. Memory: Retains all system settings in non-volatile memory.
  - 5. Mechanical Specifications:
    - a. Wiring: The System Field Device shall not require wiring connections to the System apart from pre-terminated, quick connecting 18 AWG, polarity independent quick connecting Class 2 communication bus.
  - 6. Environmental Specifications:
    - a. Operating Temperature Range: -40 deg C to +55 deg C.
    - b. Humidity: 0 percent to 100 percent RH condensing rated for damp locations.  
0 percent to 95 percent RH non-condensing rated for indoor locations.
- N. Energy Control Unit
- 1. General: The Energy Control Unit (ECU) is a rack or wall mounted lighting control device that collects, processes and distributes lighting control information to System Field Devices and lighting controllers over a Class 2 communication bus. Each ECU has multiple Class 2 communication channels and can control a large quantity of nodes (sensors, lighting controllers, 0-10V Dimming, Fixed Output Ballasts and 0-10V LED Drivers.) per channel, per the manufacturers recommended maximum. The ECU is the central intelligence point for the area that it controls, collecting signal information from sensors, lighting controllers and personal control software and determining appropriate brightness levels or on/off status for each fixture or zone. Each ECU has an Ethernet connection for communication with a facility's or tenant's Local Area Network (LAN) to enable desktop personal control.
    - a. Shall interconnect with other ECUs and System Server Unit (SSU) using standard Ethernet connection that employs TCP/IP protocol.
    - b. Control units shall at minimum meet the mechanical, electrical, data, electromagnetic and environmental specifications listed below.
  - 2. Mechanical Specifications:
    - a. Shall mount in a standard 1 inch rack (1U width), or alternatively where no rack is shown, via an individual wall mount.

3. Electrical Specifications:
    - a. Power Supply: 120V/60Hz/200W. Provide dedicated 120V receptacle fed from a dedicated normal power circuit; do not connect to a UPS or normal/emergency power source.
  4. Data Specifications:
    - a. Shall have 8 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting Class 2 communication bus that supplies 24 VDC
    - b. Each ECU channel shall support up to 100 nodes or 800 nodes in total.
    - c. Each ECU shall have two Ethernet 10/100Base - Tx Cat 5 RJ45 ports that employs TCP/IP protocol:
      - 1) Lighting Control Network
      - 2) Tenant LAN Access Point
    - d. Shall have a status LED on front of unit.
    - e. Shall have configuration stored in non-volatile flash memory.
  5. Shall comply or exceed the following electromagnetic requirements:
    - a. EN 61000-4-2
    - b. EN 61000-4-4
    - c. EN 61000-4-5
    - d. FCC Part 15/ICES-003
  6. Environmental Specifications:
    - a. Operating Temperature Range: -20 deg C to +40 deg C.
    - b. Humidity: 0 percent to 95 percent RH non-condensing.
- O. System Server Unit
1. General: System Server Unit (SSU) shall host the lighting control system database for all the lighting control devices. Server shall have the ability to:
    - a. Remotely access a system in order to change system settings or configuration;
    - b. Analyze system performance or energy data or generate system report;
    - c. Record energy consumption with average sampling every 5 minutes for unlimited duration;
    - d. Host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
    - e. Optionally can reside on a client server (virtual server) thus eliminating the need for dedicated physical hardware if desired;
    - f. Interconnect with ECUs over standard Ethernet connection that employs TCP/IP protocol;

2. Hardware based servers shall at minimum meet the specifications listed below:
  - a. Specifications:
    - 1) Mechanical Specifications:
      - a) Shall mount in a standard 19 inch rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
  - b. Electrical Specifications:
    - 1) Power Supply: 120V/60Hz/200W. Provide dedicated 120V receptacle fed from a dedicated normal power circuit.
  - c. Regulatory:
    - 1) FCC (US only) Class A.
    - 2) DOC (Canada) Class A.
    - 3) UL 60950.
    - 4) CAN/CSA-C22.2 No. 60950.

P. Communication Wire

1. Wiring: 18 AWG, pre-fabricated, polarity independent quick connecting wiring. The system shall have the capability to use both Class 1 and Class 2 wiring. The maximum connected length of wiring shall be 2500 ft. per channel.
2. Field Bus: Integrates peripheral devices such as 0-10V ballasts and/or 0-10V LED drivers, occupancy sensors, photo sensors, relay-based controls, power packs and low voltage wall controls into a complete, networked programmable lighting control system. Provides power to photo sensors, PIR occupancy sensors and dual-technology occupancy sensors. Devices may be connected randomly on the network and special termination of each network channel is not required.
3. Field bus shall at minimum meet the specifications listed below:
  - a. Specifications:
    - 1) Class 2 communication bus.
    - 2) Prefabricated one ft., five ft., ten ft., 15 ft., 20 ft., 25 ft. and 50 ft. lengths.
    - 3) Daisy chain topology
    - 4) Prefabricated with 2-wire connectors.
    - 5) Flame rated jacket for plenum use NFPA 262 (UL: FT6, CSA: CMP).
    - 6) Power Supply: 12 VDC (up to 24 VDC) to sensors.

Q. Conductors and Cables

1. Class 2 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 18 AWG.

R. Lighting Control Panels

1. General
  - a. Addressing: All lighting control panels shall be individually addressable via Central Control Software.

- b. Communication: All lighting control panels shall communicate via the same prefabricated, quick connecting low voltage wiring as all other devices.
- c. Wiring: Relay control panels shall be interconnected on the same field bus as all other system components.

S. Lighting Control System Software

1. Personal Control Software: Enables individuals in a building to control lighting levels in their workspace from their own desktop PC. User can control the light level of each fixture in their workspace or can control all of the fixtures together as a group. Preset lighting scenes may be stored, recalled and modified. This software shall have the capability of acting as a "virtual occupancy sensor" for the system by detecting keyboard or mouse activity on each PC for incremental occupancy status data.
  - a. Technical Information:
    - 1) TCP/IP network traffic < 2kb/s.
2. Web based Personal Control Software: This feature allows individuals to control lighting levels in their workspace without the requirement for installation of software on client PCs. Individuals can access the interface through the web browser and perform individual fixture dimming control, on/off switching, modify and save preset lighting scenes.
3. Technical Information: Adobe Flash ® based user interface.
  - a. System Requirements:
    - 1) Internet web browser with Flash® Player 8 or later.
    - 2) Internet/Intranet connection.
    - 3) SSU enabled and configured to host dynamic website.
    - 4) Network connection with access to a network-enabled CU.
4. Web based Central Control Software: Central control software application is used to commission, configure and manage the system. Every system parameter in a building (or campus of buildings) is configured for each individual user or space and baseline settings are established for each of the following (depending on the basis of design) system features:
  - a. Daylight harvesting.
  - b. Occupancy control.
  - c. Smart time scheduling.
  - d. Task tuning.
  - e. Personal control.
  - f. Load shedding.
    - 1) Software utilizes a web based interface that permits a user to easily navigate between zones, floors or different buildings and allows a user to zoom in or zoom out of specific areas of a building. Both 3-dimensional and 2-dimensional multi-floor views shall be available. System features such as creation of zone hierarchies, overlapping and support zone definitions, user access rights, timeout settings for occupancy sensors, calibration of light levels for daylight harvesting and the configuration of multiple time schedule profiles shall be available. A web based Graphical User Interface (GUI) application



integral to the system will be used to develop a dynamic, real-time, point-and-click graphic of each floor plan with representation of all light fixtures, lighting controllers, sensors, and switches. A central system server will be provided to support system data base and enterprise control management.

5. System Requirements:
  - a. Software must be able to run on a Windows Operating systems (Windows XP or newer) and also on Apple Mac Intel PCs (Mac OS 10.4 or newer).
  - b. Must support all common browsers, i.e.,
    - 1) Internet Explorer 6.0 or later
    - 2) Mozilla Firefox 3.0 or later
    - 3) Safari
    - 4) Google Chrome
  - c. Network connection with access to network-enabled CUs.
  - d. Color gradient ("weather map" type) data view (see below for an example) shall be available to display the following criteria:
    - 1) Current energy consumption
    - 2) Current energy savings
    - 3) Current fixture brightness
    - 4) Current fixture status
    - 5) Current occupancy data
    - 6) Current load shedding status
    - 7) Other custom modes that may be specified elsewhere

T. Photo Sensor:

Photo sensors shall at minimum meet the specifications listed below:

1. General Specifications:
  - a. Shall be Class 2, low voltage.
  - b. Ambient light sensor designed to interface directly with the analog input of the Lighting Control System.
  - c. Sensor shall supply an analog signal to the ALCS proportional to the light measured.
  - d. Sensor output shall provide for zero or offset based signal.
  - e. Sensor shall be capable of a fully adjustable response in the range between 0 and 10,000 foot candles with a +/- 1 percent accuracy at 70 deg F.
  - f. Input: 10VDC.
  - g. Minimum Output: 0 VDC.
  - h. Maximum Output: 10 VDC.
  - i. Sensor housing shall be flame retardant and meet UL 94 HB standards.
  - j. Operating Temp: -10 deg C to 60 deg C.
  - k. The sensitivity adjustments shall be at sensor body, and outside of the sensor's viewing angle.

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- I. The sensor housing shall be flame retardant and meet UL 94HB standards
  2. Interior:
    - a. Indoor sensors shall have a Fresnel lens, with a 60 degree cone of response. The indoor sensor range shall be between 0 and 750 FC.
  3. Exterior:
    - a. Outdoor models shall have a hood over the aperture to shield the sensor from direct sunlight. The outdoor sensor circuitry shall be completely encased in an optically clear epoxy resin. Outdoor sensors shall mount to a standard threaded 1/2 in. conduit or fit a 1/2 in. knockout. The Outdoor sensor range shall be between 0 and 750 FC.
  4. Atrium:
    - a. The Atrium sensors shall have a translucent dome with a 180 degree field of view. Atrium sensor shall mount to a standard treaded 1/2 in. conduit or fit a 1/2 in. knockout. Atrium sensor range shall be from 2 to 2,500 FC.
  5. Skylight:
    - a. The Skylight sensors shall have a translucent dome with a 180 degree field of view. Skylight sensor shall mount to a standard treaded 1/2 in. conduit or fit a 1/2 in. Skylight sensor range shall e between 10 and 7,500 FC.
- U. Occupancy Sensors
1. Environmental:

Operating Temperature Range: 0°C to 40°C

    - a. Relative Humidity: 0 percent to 95 percent non-condensing
    - b. Ceiling Mount Occupancy/Vacancy Sensors
      - 1) Sensing mechanism:
      - 2) Dual technology (ultrasonic / passive infrared):
      - 3) Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
      - 4) Utilize an operating frequency of 32kHz or 40kHz that shall be crystal controlled to operate within plus or minus 0.005 percent tolerance.
      - 5) Electrical: Rating: 12 VDC input voltage, up to 40 mA current draw.
      - 6) Sensors shall turn off or reduce lighting automatically after reasonable time delay when a room or area is vacated by the last person to occupy the space
      - 7) Sensor shall accommodate all conditions of space utilization and all irregular work hours and habits.
      - 8) Sensors shall be UL listed.
      - 9) Sensors shall be fully adaptive and adjust their sensitivity and timing to ensure optimal lighting control for any use of the space
      - 10) Sensors shall have field adjustable controls for time delay and sensitivity to override any adaptive features. Sensor timeouts shall be configurable by System software.
      - 11) Power failure memory:

- 12) Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and learned parameters saved in protected memory shall not be lost.
- 13) Provide all necessary mounting hardware and instructions.
- 14) Sensors shall be Class 2 devices.
- 15) Indicate viewing directions on mounting bracket for all Ceiling mount sensors.
- 16) Provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology. Field prepare proper maskings for each space to eliminate unnecessary sensing beyond the space in which the sensor is located.
- 17) Provide an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options.
- 18)

V. Examination

1. Site Verification: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.
2. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

W. Installation

1. The Electrical Sub-contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Sub-contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans (including but not limited to System Field Devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire). The Electrical Sub-contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.
2. Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.
3. Related Product Installation: Refer to other sections listed in Related Sections for related products' installation.

X. Sensor Installation

1. Adjust sensitivity to cover area installed
2. Set time delay on occupancy sensors that are connected to the lighting control system to the minimum. Time delays shall be controlled via Central Control Software.
3. Sensor shall be powered through Input Module. No external power packs shall be used for powering sensors.
4. Install occupancy sensors on vibration free stable surface.
5. Install atrium and skylight light sensor facing toward window or skylight.

6. Install interior light sensor in ceiling facing the floor.

Y. Wiring Installation

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.
2. Wiring within Enclosures: Comply with NEC & CEC. Separate power-limited and non power-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

Z. Software Installation

1. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current site licenses for software.

AA. Field Quality Control

1. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
2. Perform the following field tests and inspections with the assistance of a factory-authorized service representative:
  - a. Operational Test: After installing lighting controllers and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Lighting control devices will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

BB. Commissioning Requirements

1. Commissioning: The manufacturer shall supply factory trained representatives for a minimum of 24 hours to commission the lighting control system. Manufacturer shall start up all lighting control equipment and verify that it meets the requirements of this specification.
2. Training: As part of the standard commissioning process, the manufacturer shall train the owner's representatives in the operation of the system to a maximum of 4 hours per building. Manufacturer shall also provide owner's representatives with system operating manuals together with a system training video. Specific training on the operation of the tunable white lighting shall be provided. In addition to the 4 hours an additional 4 hours of training shall be provided for spaces utilizing tunable white light.

3. Technical Support: The manufacturer shall supply 24/7 technical telephone support to the client. If the manufacturer does not provide 24/7 support, they must provide a list of contacts (names and cell phone numbers) in the event of a system failure during non-business hours.
4. Replacement components: The manufacturer shall be able to ship replacement parts within 24 hours for any component that fails during the warranty period.
5. Extended Service Coverage: Maintenance agreements shall be available from the manufacturer to provide service for the system both during and after the warranty period.
6. Requests for commissioning shall be at least two weeks prior to date desired for commissioning.
7. Electrical Sub-contractor shall perform functional testing under the guidance of commissioning agent and in accordance with factory specified guidelines.
8. Factory appointed personnel shall provide commissioning services for the lighting control system.
  - a. Verify proper communication over control wires.
  - b. Map addresses of occupancy sensors (via Input Modules), light level sensors (via Input Modules), lighting controllers to control units and system server.
  - c. Map all system data to appropriate BACnet points and assist BMS sub-sub-contractor in programming all points into the BMS system and verifying their proper functionality.
  - d. Verify communication to control units and system server.
  - e. Configure occupancy sensors, light level sensors, lighting controllers and other contacts to suit design specifications.
  - f. Configure and program lighting control sequences as described on contract documents.
  - g. Demonstrate to Owner and Engineer proper operation of all areas the system is installed.

CC. Testing

1. Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, a qualified factory representative shall completely configure and test the system.
2. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

DD. Demonstration

1. Engage a factory-authorized service representative to train Owner's maintenance personnel and building supervisors to adjust, operate, utilize, troubleshoot, conduct software installation, and maintain lighting controls and software training for PC-based control systems. Provide up to eight hours of on-site training with audio and video recorded. Provide a hard copy of manuals, instructional videos, and recorded training session(s) on CD or DVD.
2. Submit shop drawings indicating outline dimensions, connection and support points, weight, specified ratings and materials.

3. Submit product data indicating standard model design tests and options.
4. Submit manufacturer's installation instructions.

EE. OPERATION AND MAINTENANCE DATA

1. Submit operation and maintenance data under.
2. Include procedures for cleaning unit, and replacing components.

FF. QUALITY ASSURANCE

1. Manufacturer: Company specializing in distribution transformers with Five [5] years Documented experience.

2.11 ELECTRICAL POWER EQUIPMENT

A. Motor Controls - Manual and Solid State:

1. Individually mounted starters shall be NEMA rated solid state type with thermal overload on each reduced voltage start.
2. Motor Starters shall be furnished by Electrical Sub-Contractor unless part of package mechanical equipment such as rooftop units. Refer to equipment schedules on Electrical Plans and provide accordingly.
3. The solid state motor controller shall use silicon controlled rectifiers (SCR's) to control the voltage to the motor windings. Two SCR's shall be used in a back-to-back arrangement in each phase to allow alternating current to pass to the motor. When SCR triggering is delayed, the voltage to the load shall be reduced. This phase-controlled operation provides soft starting with stepless acceleration. Once the motor is running, voltage reduction can improve the motor's operating point at partial load, saving energy and lowering the reactive current. If one or more shorted SCRs are detected, the starter shall not energize. A fault LED will light and if provided with a shunt trip, the main circuit breaker will trip. Provide pump stop option to eliminate water hammer in pumping systems, by giving a controlled decel to the motor voltage. This process shall allow for smooth pressure reduction and quiet check valve operation. The controller shall trip off the line if one or more phases is lost.
4. Starters shall be of size and type required for particular motor horsepower and voltage. Minimum size starter to be size 1 FVNR, unless noted otherwise.
  - a. Starters shall have OL reset button, green push-to-test type pilot light to indicate "ON", and "HAND-OFF-AUTO" switch in cover.
  - b. Starters to have 120 volt control transformers with fused output being provided for those units operating on 277/480 volt system.
  - c. Provide Class 20 fixed heater overloads with auto/manual reset.
  - d. Provide four sets of auxiliary contacts of convertible type N.O. to N.C. for each starter.
  - e. Motor starters shall have NEMA I enclosures. Those in wet locations shall be NEMA 3R.
  - f. Acceptable Manufacturers:
    - 1) Westinghouse/Culter-Hammer
    - 2) Square D/Groupe Schneider
    - 3) Siemens
    - 4) Allen Bradley

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- 5) General Electric
  - 6) Or equal
5. Manual motor starters shall have pilot lights and shall be furnished with thermal overloads on each phase.
- B. Motors: Each motor shall have disconnect switch and starter provided under this section.
1. Provide motor terminal boxes for each motor not furnished with same.
- C. Disconnect Switches:
1. Disconnect (safety) switches shall conform to industrial standards of NEMA, be UL listed and shall be heavy duty type, quick-make, quick-break type with interlocking cover mechanism and provisions for padlocking switch handle in "OFF" position. Three pole toggle switches are not acceptable as substitute for disconnect switches.
  2. Disconnect switches shall be of fused or unfused type as indicated with number of disconnecting poles indicated. The grounded conductor shall not be switched. Switches for use with current limiting fuses shall be rejection type and those used in conjunction with motors shall be horsepower rated. Provide oversize termination lugs if required by conductor size.
  3. Enclosures shall be of proper NEMA type for intended location and shall be phosphate coated or equivalent code gauge galvanized sheet steel with ANSI #24 dark gray baked enamel finish.
  4. Acceptable Manufacturers:
    - a. Culter-Hammer/Westinghouse
    - b. Square D/Groupe Schneider
    - c. Siemens
    - d. Allen Bradley
    - e. General Electric
    - f. Or equal
- D. Fuses:
1. Secondary system fuses, rated at 600 volts or less, shall be UL listed and constructed in conformance with the applicable standards set forth by NEMA and ANSI. All fuses of a particular class shall be of same manufacturer.
  2. All fuses in distribution panelboards and switchboards shall be class "L" above 600 amperes and class "RK1" for 600 amperes and below.
  3. Main, Feeder, and Branch Circuits:
    - a. Circuits 601 amperes and above shall be protected by (Bussmann type KRP-C LOW-PEAK) current limiting time delay fuses.
    - b. Circuits 0-600 amperes shall be protected by (Bussmann "LOW-PEAK" dual element), time delay current limiting fuses, LPN-RK (250 volts), LPS-RK (600 volts), UL class RK-1.
  4. Acceptable Manufacturers:
    - a. Bussmann, Division of McGraw
    - b. Gould/Shawmut
-

- c. GEC-ALSTHOM
- d. Or equal

## 2.12 ELECTRICAL SYSTEM CONTROLS AND INSTRUMENTS

- A. Provide a complete power system consisting of branch circuits, motor disconnect switches, pushbutton stations, motor starters, and other devices to connect up and leave in operating condition each piece of electrically operated equipment provided either under this section or other Divisions.
- B. All control wiring, not indicated in the electrical specifications or not shown on electrical drawings, will be provided by Temperature Control Subcontractor.

## 2.13 GROUNDING SYSTEM

- A. All equipment and systems shall be grounded. Refer especially to NEC Section 250 Requiring Connections to Building Steel, Foundation, Water Service, and Interior Piping. Provide transformer pad grounding in accordance with utility company standards.
- B. The grounded conductor shall be supplemented by an equipment grounding system.
- C. The equipment grounding system shall be installed so all conductive items in close proximity to electrical circuits operate continuously at ground potential and provide a low impedance path for ground fault currents.
- D. Grounding conductors shall be so installed as to permit shortest and most direct path to ground.
- E. Maximum measured resistance to ground of 5.0 ohms shall not be exceeded. Ground separately derived systems (dry type transformers) in accordance with Article 250-30 by grounding neutral to transformer ground lug and providing insulated grounding electrode conductor to nearest effectively grounded building steel or, if unavailable, to nearest available effectively grounded metal water pipe.
- F. Equipment grounding conductors and straps shall be sized in compliance with Code Table 250-122.
- G. Grounding conductors shall be insulated with green color. Grounding conductors for use on isolated ground receptacles shall be green with trace color to differentiate between normal ground conductors.
- H. Branch circuits shall consist of phase and grounded conductor installed in common metallic raceway. All receptacle circuits shall have dedicated neutrals. All circuits shall have a separate insulated grounding conductor installed. Any flexible cable system or non-metallic raceway grounding system shall have an insulated grounding conductor. Any cable system for use on isolated ground circuits shall have both an isolated ground conductor as well as an equipment ground conductor, both of which shall be insulated.
- I. Each electrical expansion fitting shall be furnished with a bonding jumper. Provide grounding bushings and ground connections for all raceways terminating below equipment where there is no metal-to-metal continuity.



- J. Continuity between all metallic and nonmetallic raceway systems and equipment shall be maintained.
- K. Outdoor lighting fixtures shall be grounded and bonded in common with building system via a separate grounding conductor.
- L. Refer to Technology Specifications for additional grounding requirements.

#### 2.14 MAIN BUILDING SWITCHBOARD

- A. Main building switchboard shall be constructed in accordance with UL 891 and ANSI standards and of the required number of vertical sections bolted together to form one metal enclosed rigid structure. The sides, top, and rear shall be covered with removable plates. Switchboard shall include all protective services and equipment as listed on drawings with necessary interconnections, instrumentation, and control wiring. Buses shall be aluminum. Provide oversize termination lugs for any terminations requiring same due to conductor sizing.
- B. Record drawings shall be furnished with the following: Complete rating, short-circuit withstandability of bus and of lowest rated device, overall outline dimensions, including space available for raceways, circuit schedule showing circuit number, device description, device fuse clip ampere rating, conductor ratings and one-line diagram with each circuit device numbered.
- C. Each section shall be 90 in. high, self-supported, and same depth as incoming line section, approximately 30 in. deep. Main protective device shall be individually mounted with front coverplate and bus connection straps. Where called for on schedule, "space" shall mean to include necessary bus, supports, and connections, leaving out only the breaker itself. Bus structure shall be arranged to permit future additions.
- D. Switchboard shall be arranged for operation as follows:
  - 1. Voltage - 480Y/277 volts
  - 2. Frequency - 60 cycles
  - 3. Service - 3 phase, 4 wire, ampere capacity as indicated on drawings.
  - 4. Neutral - full capacity
  - 5. Available short circuit current at line terminals – 100,000 RMS amperes symmetrical.
  - 6. Integrated equipment rating - 100,000 AIC
  - 7. Copper ground bus, full length
  - 8. UL service entrance label
- E. The main shall have solid-state trip device (100 percent rated) with the following features:
  - 1. Adjustable ampere setting between 50-100 percent rating
  - 2. Adjustable long time delay
  - 3. Adjustable short time pickup
  - 4. Adjustable short time delay
  - 5. Fixed instantaneous at 15 times rating

6. Adjustable ground fault pickup
  7. Adjustable ground fault delay
- F. Provide electrical metering and voltage protection system equal to Square D Power Logic, Westinghouse IQ Data Plus or Siemens 4700 Series at main breaker.
  - G. Branch Devices shall be standard molded case circuit breakers, current limiting circuit breakers, or other devices as scheduled. Branch devices shall be mounted in panelboard type construction.
  - H. Include space and provisions for utility company metering. Refer to electric service section of this Division.
  - I. Acceptable Manufacturers: Square D is the Basis of Design.
    1. Square D/Groupe Schneider
    2. Cutler-Hammer/Westinghouse
    3. Siemens
    4. Or equal

#### 2.15 PANELBOARDS

- A. Panelboards shall be dead-front, door in door safety type equipped with single or multi-pole circuit breakers suitable for 120/208 volt or 277/480 volt, 3 phase, 4 wire operation.
- B. Buses shall be aluminum. Panelboards shall have a circuit directory card mounted in a frame with plastic cover on inside of door. Panelboards to have a copper ground bus with terminals for each circuit. Panelboards serving isolated ground receptacles shall have a separate ground bus for terminations of the isolated grounds. The isolated ground bus shall be mounted to the panel tub via non-conducting means with a separate grounding conductor run to the normal panel ground bus. Provide oversize lugs for any termination requiring same due to oversize conductors. Provide 200% neutral buses on all 120/208 volt panelboards.
- C. Cabinets shall be minimum of 20 inch wide and be made of code gauge steel. Surface type shall be ordered without knockouts.
- D. Trims shall be made of code gauge steel, surface or flush as indicated. Panelboards shall be keyed alike. Trims shall be provided with full length piano hinge on one side, and secured to tub with sufficient quantity of latches opposite the hinge side to allow trim to fit flush with tub and when released, allow full access to wiring gutters. Inner door shall allow access to circuit breakers only.
- E. Panelboards shall be of the following types with minimum circuit breaker frame sizes listed below. Refer to schedules for larger circuit breaker frame sizes due to fault current availability. Square D is the Basis of Design.
  1. 120/208 volt, three phase, four wire. Symmetrical interrupting capacity 10,000 AIC.

Style	
Westinghouse type PRL-1	BAB Breakers (bolt-on)

- 
- |                    |                           |
|--------------------|---------------------------|
| Square D type NQOD | QOB Breakers<br>(bolt-on) |
| Siemens type CDP-7 | BQ Breakers<br>(bolt-on)  |
| Or equal           |                           |
2. 277/480 volt, three phase, four wire. Symmetrical interrupting capacity 65,000 AIC.
- Style
- |                         |                            |
|-------------------------|----------------------------|
| Westinghouse type PRL-2 | GHB Breakers<br>(bolt-on)  |
| Square D type NEHB      | EHB Breakers<br>(bolt-on)  |
| Siemens type CDP-7      | BQCH Breakers<br>(bolt-on) |
| Or equal                |                            |
3. Distribution Panels:
- a. Where scheduled as circuit breaker type, symmetrical interrupting capacity 65,000 AIC.
  - b. Westinghouse type PRL-3      FD Breakers
  - c. Square D I-Line type      FA Breakers
  - d. Siemens SPP      FXD6 Breakers
  - e. Or equal
- F. Panelboards and distribution panels shall be of same manufacturer as switchboard. Refer to drawings where higher interrupting are required.
- G. All power panels fed from K-13 transformers shall have surge protection. Coordination and Arc flash study shall be submitted with shop drawing submittal. All circuit breaker selection shall meet study recommendations and shall be provided as recommended by study.
- H. Electrical Sub-contractor shall provide infrared scanning of all panelboards after three months past substantial completion. Provide report indicating status of all terminations at respective panelboards per phase.
- 2.16 DRY-TYPE TRANSFORMERS
- A. Transformer Specification:
- 1. Compatibility: This product must facilitate the ability of the electrical system to supply a sinusoidal voltage in order to improve the long-term compatibility of the electrical system with all types of linear and nonlinear connected loads today and in the future. All national and international standards on harmonics and power quality set limits on levels of voltage distortion to maintain compatibility.

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2. Alluminum-wound, 3-phase, common core, ventilated, dry-type, isolation transformer built to NEMA ST20 and relevant NEMA, UL and IEEE standards; 200 percent rated neutral; 60Hz rated; Transformers 750 kVA and less, 600 volt primary and less, shall be U.L. and CSA Listed and bear the label. All terminals, including those for changing taps, must be readily accessible by removing a front cover plate. Windings shall be continuous with terminations brazed or welded. 10kV BIL.
  3. Insulation System:
    - a. Shall be NOMEX-based with an Epoxy Co-polymer impregnant for lowest environmental impact, long term reliability and long life expectancy
    - b. Class: 220 degrees C
    - c. Impregnant Properties for low emissions during manufacturing, highest reliability and life expectancy
    - d. Epoxy co-polymer
    - e. VOC: less than 1.65 lbs/gal (low emissions during manufacturing)
    - f. Water absorption (24hrs at 25C): less than 0.05 percent (superior insulation, longer life)
    - g. Chemical Resistance: Must have documented excellent performance rating by supplier
    - h. Dielectric Strength: minimum of 3200 volts/mil dry (for superior stress, overvoltage tolerance)
    - i. Dissipation Factor: max. 0.02 at 25C to reduce aging of insulation, extending useful life
  4. Operating Temperature Rise: 130 degrees C in a 40 degree C maximum ambient
  5. Noise levels:
    - a. Per NEMA ST-20
    - b. Production Test every unit. Data to be available upon request.
  6. UL Listed & Labeled K-Rating: K-7 or higher
  7. Maximum No Load Losses
    - a. Transformers are energized 24 hours a day for their entire life, potentially 40 years or more. These losses are incurred whether the transformer is loaded or not, and cost the user many times the purchase price of the transformer even at current energy rates.
    - b. No load losses shall not exceed: 15kVA: 60W, 30kVA: 99W, 45kVA: 130W, 75kVA: 180W, 112.5kVA: 260W, 150kVA: 330W, 225kVA: 450W, 300kVA: 560W, 500kVA: 850W
  8. Efficiency at 15 percent loading
    - a. Data shows that transformers are typically very lightly loaded for extended periods of time, therefore to minimize operating cost under real world loading conditions, efficiency at 1/6 loading shall be maximized.

- b. Efficiency at 1/6 load shall meet or exceed: 15kVA: 97.3 percent, 30kVA: 97.6 percent, 45kVA: 97.9 percent, 75kVA: 98.2 percent, 112.5kVA: 98.4 percent, 150kVA: 98.5 percent, 225kVA: 98.6 percent, 300kVA: 98.7 percent, 500kVA: 98.8 percent, 750kVA: 98.9 percent
- 9. DOE 10 CFR Part 430 CSL 3 Efficiency requirement, tested per NEMA TP-2:
  - a. Shall meet or exceed: 15kVA: 97.6 percent, 30kVA: 98.1 percent, 45kVA: 98.3 percent, 75kVA: 98.6 percent, 112.5kVA: 98.8 percent, 150kVA: 98.9 percent, 225kVA: 98.9 percent, 300kVA: 99.0 percent, 500kVA: 99.1 percent, 750kVA: 99.2 percent
- 10. Efficiency under k-7 nonlinear load at 50 percent of nameplate rating:
  - a. 15kVA: 97.3 percent, 30kVA: 97.7 percent, 45kVA: 97.9 percent, 75kVA: 98.4 percent, 112.5kVA: 98.7 percent, 150kVA: 98.8 percent, 225kVA: 98.8 percent, 300kVA: 98.8 percent, 500kVA: 98.9 percent, 750kVA: 98.9 percent
- 11. Voltage Taps: For transformers 30kVA-300kVA, provide two 2-1/2 percent full capacity taps above and below nominal primary voltage. For transformers 15kVA and smaller as well as 500kVA and larger provide one 5 percent full capacity tap above and below nominal primary voltage.
- 12. Impedance: Between 3.5 percent and 5.8 percent unless otherwise noted.
- 13. Enclosure type: Ventilated NEMA 2, drip-proof [optional NEMA 3R]
- 14. Maximum Footprint for 130 degree C rise model in a NEMA 1 enclosure:
  - a. 17 in. Wide x 17 in. Deep x 27 in. High for 15kVA.
  - b. 26 in. Wide x 18 in. Deep x 30 in. High for 30kVA, 45kVA
  - c. 33 in. Wide x 22 in. Deep x 40 in. High for 75kVA, 112.5kVA
  - d. 38 in. Wide x 28 in. Deep x 52 in. High for 150kVA
  - e. 38 in. Wide x 32 in. Deep x 52 in. High for 225kVA, 300kVA
  - f. 52 in. Wide x 38 in. Deep x 61 in. High for 500kVA
  - g. 63 in. Wide x 46 in. Deep x 67 in. High for 750kVA

B. Regulations for low-voltage general purpose dry-type transformer (LVGP).

Single Phase		Three Phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
15	97.7	15	97.89
25	98.0	30.=	98.23
37.5	98.2	45	98.40
50	98.3	75	98.60
75	98.5	112.5	98.74
100	98.6	150	98.83
167	98.7	225	98.94
250	98.8	300	99.02
333	98.9	500	99.14
		750	99.23
		1000	99.28

- C. Transformer Features
  - 1. Electrostatic Shield: Each winding shall be independently single shielded with a full-width copper electrostatic shield.
- D. Acceptable Manufacturers or Approved Equal: Square D is the Basis of Design.
  - 1. Square D Company
  - 2. Powersmiths International Corp.
  - 3. Eaton
  - 4. Or Equal

## 2.17 ELECTRIC SERVICE

- A. Coordinate and cooperate with Eversource, hereinafter called utility company, with respect to providing service and metering.
- B. Provide all system raceways, elbows, pull wires, grounding for vault including mesh. Utility company will provide pad mounted transformer and primary conductors including making up of all terminations and connections.
- C. Provide secondary service complete including all conductors, raceways, and connectors at transformer. Provide oversize lugs if required due to conductor sizing. Attachment of secondary conductors to the transformer terminals will be done by utility company.
- D. All work to be done in accordance with utility company standards.
- E. Metering: All usage will be on one secondary meter. Utility Company will furnish current transformers and potential transformers to be installed in transformer. Meter socket shall be provided under this section and located in accordance with Utility Company Standards. Meter will be by Utility Company. Meters shall be ordered with KYZ Pulse output for connection to Building Management System.

## 2.18 FIRE ALARM AND DETECTION SYSTEM WITH MASS NOTIFICATION (Voice Evacuation Required)

- A. Description:
  - 1. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.
  - 2. The fire alarm system shall comply with requirements of latest NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
  - 3. The fire alarm manufacturer shall be of the highest caliber and insist on the highest quality. The system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

4. The FACP and peripheral devices shall be manufactured 100 percent by a single U.S. manufacturer (or division thereof).
5. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing.
6. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication
7. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final check-out and to ensure the systems integrity.

B. Scope:

1. An intelligent reporting, microprocessor controlled fire detection and system shall be installed in accordance with the specifications and drawings.
2. Basic Performance:
  - a. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto NFPA Style 7 (Class A) Signaling Line Circuits (SLC).
  - b. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D).
  - c. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z).
  - d. Digitized electronic signals shall employ check digits or multiple polling.
  - e. Power for initiating devices and notification appliances must be from the main fire alarm control panel, the transponder to which they are connected or to a Field Charging Power Supply (FCPS).
  - f. A single ground or open on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
  - g. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
3. Basic System Functional Operation: When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
  - a. The FACP alarm LED on the FACP shall flash.
  - b. A local piezo-electric signal in the FACP control panel shall sound.
  - c. The 80-character LCD display on the local FACP node and on the intelligent network display shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.
  - d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.

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- e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.
- 4. Software Modifications:
    - a. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
    - b. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm network on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.
  - 5. Certifications:
    - a. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer and trained on network applications. Include names and addresses in the certification.
- C. Applicable Publications:
- 1. The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.
    - a. National Fire Protection Association (NFPA) - USA:
      - 1) No. 72 National Fire Alarm Code
      - 2) No. 70 National Electric Code
      - 3) No. 101 Life Safety Code
    - b. Underwriters Laboratories Inc. (UL) - USA:
      - 1) No. 50 Cabinets and Boxes
      - 2) No. 268 Smoke Detectors for Fire Protective Signaling System
      - 3) No. 864 Control Units for Fire Protective Signaling Systems
      - 4) No. 268A Smoke Detectors for Duct Applications
      - 5) No. 521 Heat Detectors for Fire Protective Signaling Systems
      - 6) No. 228 Door Closers-Holders for Fire Protective Signaling Systems
      - 7) No. 464 Audible Signaling Appliances
      - 8) No. 38 Manually Actuated Signaling Boxes
      - 9) No. 346 Waterflow Indicators for Fire Protective Signaling Systems



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- 10) No. 1481            Power supplies for Fire Protective Signaling Systems
  - 11) No. 1076           Control Units for Burglar Alarm Proprietary Protective Signaling Systems
  - 12) No. 1971           Visual Notification Appliances
  - c. Local and State Building Codes.
  - d. All requirements of the Authority Having Jurisdiction (AHJ).
- D. Approvals:
- 1. The system must have proper listing and/or approval from the following nationally recognized agencies:
    - a. UL                    Underwriters Laboratories Inc.
    - b. FM                    Factory Mutual
    - c. MEA                  Material Equipment Acceptance (NYC)
    - d. CSFM                California State Fire Marshal
  - 2. The fire alarm control panel, shall meet the modular labeling requirements of Underwriters Laboratories, Inc. Each subassembly, including all printed circuits, shall include the appropriate UL modular label. Systems which do not include modular labels which may require return to the manufacturer for system upgrades, and are not acceptable.
- E. Equipment and Material - General:
- 1. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.
  - 2. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.
  - 3. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.
  - 4. All fire alarm equipment that requires keys shall be keyed alike.
- F. Conduit and Wire:
- 1. Conduit:
    - a. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
    - b. All wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit. Red plenum rated FA cable where run concealed.

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- c. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
  - d. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
  - e. Conduit shall not enter any FACP, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
  - f. Conduit shall be 3/4 inch (19.1 mm) minimum.
2. Wire:
    - a. All fire alarm system wiring must be new, unless specified herein.
    - b. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 16 AWG (1.02 mm) for initiating device circuits and signaling line circuits, and 14 AWG (1.32 mm) for notification appliance circuits.
    - c. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
    - d. Wiring used for the SLC multiplex communication loop shall be twisted and shielded unless specifically excepted by the fire alarm equipment manufacturer.
    - e. All field wiring shall be completely supervised.
  3. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for the intended purpose.
  4. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
  5. The FACP shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution Panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The FACP cabinet shall be grounded securely to either a cold water pipe or grounding rod.
- G. Fire Alarm Control Panel and Fire Command Center:
1. Fire alarm control panel shall be Notifier, FCI, Autocall, Siemens or equal. Panel shall contain a microprocessor based central processing unit (CPU). Notifier is the Basis of Design. The FACP shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, transponders, local and remote operator terminals, printers, annunciators, and other system controlled devices. Locate equipment in the Fire Command Center. Provide lockable cabinet for as built drawings in the Fire Command Center.

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2. Node Capacity and General Operation:
- a. Each node shall provide, or be capable of, expansion to 198 intelligent addressable devices per loop plus 2048 annunciation points per system. FACP shall support a minimum of 10 intelligent loops.
  - b. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit Liquid Crystal Display (LCD), individual, color coded system status LEDs, and an alpha-numeric keypad for field programming and control of the node.
  - c. All programming or editing of the existing programming the system shall be achieved without special equipment or interrupting the alarm monitoring functions of the fire alarm control panel.
  - d. The system shall include emergency voice communications utilizing distributed amplification and intelligence such that loss of operation by the main FACP will not result in the loss of evacuation signal throughout the balance of the building.
  - e. Each FACP node shall provide the following features:
    - 1) Block Acknowledge           Printer Interface
    - 2) Charger rate Control        CRT Display Interface
    - 3) Control-by-Time            Non-Alarm Module Reporting
    - 4) Day/Night Sensitivity       Periodic Detector Test
    - 5) Device Blink Control       Remote Page
    - 6) Drift Compensation Trouble Reminder
    - 7) NFPA 72, Sensitivity Test   Upload/Download to PC computer
    - 8) System Status Reports      Verification Counters
    - 9) Security Monitor Points     Walk Test
    - 10) Alarm Verification         Maintenance Alert
3. Loop Interface Board (LIB):
- a. Loop interface boards shall be provided to monitor and control each of the Signaling Line Circuit (SLC) loops in the network node. The loop interface board shall contain its own microprocessor and shall be capable of operating in local mode in the case of a failure in the main CPU of the control panel. In local mode, the loop interface board shall detect alarms and activate output devices on its own SLC loop.
  - b. The LIB shall not require any jumper cuts or address switch settings to initialize SLC Loop operations.
  - c. The loop interface board shall provide power to, and communicate with, all of the intelligent detectors and addressable modules connected to its SLC Loop over a single pair of wires. This SLC Loop shall be capable of operation as NFPA Style 4, Style 6, or Style 7.
  - d. The LIB shall be able to drive two Style 4 SLC loops, each up to 10,000 feet in length, for an effective loop span of 20,000 feet.

- e. The loop interface board shall receive analog information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular detector. The loop interface board software shall include software to automatically adjust and compensate for dust accumulation to maintain detector performance as it is affected by environmental factors. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
  - f. The LIB shall communicate with each intelligent addressable detector and addressable module on its SLC loop and verify proper device function and status. Communication with up to 198 intelligent devices shall be performed every 6 seconds or less.
4. Enclosures:
- a. Control panels shall be housed in UL listed cabinets suitable for semi-flush mounting. Cabinets shall be corrosion protected, given a rust-resistant prime coat, and the manufacturer's standard finish.
  - b. The back box and door shall be constructed of .060 steel with provisions for electrical conduit connections into the sides and top.
  - c. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.
  - d. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.
5. FACP nodes shall be designed so that it permits continued local operation of remote transponders under both normal and abnormal network communication loop conditions. This shall be obtained by having transponders operate as local control panels upon loss of network communication.
6. FACP nodes shall be modular in construction to allow ease of servicing. Each CPU and transponder shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems, which require use of external programmers or change of EPROMs are not acceptable.
7. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients including RFI and EMI.
8. FACP Power Supplies:
- a. Main power supplies shall operate on 120 VAC, 60Hz, and shall provide all necessary power for the FACP.
  - b. Each main supply shall provide 3.0 amps of usable notification appliance power, using a switching 24 VDC regulator.
  - c. The main power supply shall be expandable for additional notification appliance power in 3.0 ampere steps.
  - d. Each main power supply shall provide a battery charger for 60 hours of standby using dual-rate charging techniques for fast battery recharge. It shall charge 55 Amp hour batteries with-in a 48 hour period.
  - e. The supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults on sensitive addressable modules.

- f. It shall provide meters to indicate battery voltage and charging current.
  - g. The main power supply shall be power-limited per 1995 UL864 requirements.
9. System Circuit Supervision:
- a. Each FACP node shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communications with these devices. The FACP CPU shall continuously scan the above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information on the printer.
  - b. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off-normal position.
10. Field Wiring Terminal Blocks: For ease of service, all wiring terminal blocks shall be the plug-in type and have sufficient capacity for 18 to 12 AWG wire. Fixed terminal blocks are not acceptable.
11. Operators Terminal: Provide the following functions in addition to any other functions required for the system.
- a. Acknowledge (ACK/STEP) Switch:
    - 1) Activation of the control panel Acknowledge switch in response to a single new Alarm and/or trouble condition shall silence the local panel piezo electric signal and change the system alarm or trouble LED from flashing mode to steady-ON mode. If additional new alarm or trouble conditions exist or are detected and reported in the system, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
    - 2) Depressing the acknowledge switch shall also silence all remote annunciator piezo sounders.
  - b. Signal Silence Switch: Activation of the signal silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm activation. The selection of notification circuits and relays which are silence able by this switch shall be fully field programmable within the confines of all applicable standards.
  - c. System Reset Switch: Activation of the system reset switch shall cause all local electronically-latched initiating devices, software zones, output devices and circuits, to return to their normal condition.
  - d. If an alarm condition(s) still exists, or if they reoccur in the system after system reset switch activation, the system shall then resound the alarm conditions.

- e. System Test Switch: Activation of the system test switch shall initiate an automatic test of all intelligent/addressable detectors in the local system. The system test shall activate the electronics in each intelligent sensor, simulating an alarm condition and causing the transmission of the alarm condition from that sensor to the fire alarm control panel. The fire alarm control panel shall interpret the data from each sensor installed in the system. A report summarizing the results of this test shall be displayed automatically on the system LCD and on any CRTs or printers in the system.
  - f. Lamp Test Switch: Activation of the lamp test switch shall sequentially turn on all LED indicators, system liquid crystal display and local piezo signal, and then automatically return the fire alarm control panel to the previous condition.
12. Field Programming:
- a. The system shall be programmable, configurable and expandable in the field without the need for special tools or electronic equipment and shall not require field replacement of electronic integrated circuits.
  - b. All local FACP node programming shall be accomplished through the FACP keyboard or through the video display terminal.
  - c. All field defined programs shall be stored in non-volatile memory.
  - d. The programming function shall be enabled with a password that may be defined specifically for the system when it is installed. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level is used for status level changes such as zone disable or manual on/off commands. A second (higher-level) is used for actual change of program information.
13. Specific System Operations:
- a. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent detectors in the FACP node from each system keypad or from the keyboard of the video terminal. Sensitivity range shall be within allowed UL limits.
  - b. Alarm Verification: Each of the intelligent addressable detectors in the system may be independently selected and enabled for alarm verification. Each FACP shall keep a count of the number of times each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
  - c. System Point Operations:
    - 1) All devices in the FACP node may be enabled or disabled through the local keypad or video terminal.
    - 2) Any FACP node output point may be turned on or off from the local system keypad or the video terminal.
  - d. Point Read: The FACP node shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point will be annunciated for the parameters listed:
    - 1) Device Status
    - 2) Device Type
    - 3) Custom Device Label
    - 4) Software Zone Label

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- 5) Device Zone Assignments
  - 6) Detector Analog Value
  - 7) All Program Parameters
  - e. System Status Reports: Upon command from a password-authorized operator of the system, a status report will be generated, and printed, listing all local FACP system status.
  - f. System History Recording and Reporting: Each FACP node shall contain a history buffer that shall be capable of storing a minimum of 400 system events. Each local activation will be stored and time and date stamped with the actual time of the activation, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and or printed.
    - 1) The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.
  - g. Automatic Detector Maintenance Alert: Each FACP node shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
    - 1) If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular intelligent detector will be annunciated on the system display, network display and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
14. System Printer
- a. The system printer shall be an external printer with associated printer stand. Printer stand shall be capable of holding paper stock and shall provide a holding area for printouts.
  - b. The printer shall continue to operate from building emergency power or fire alarm system standby batteries in the event of main power loss.
  - c. The printer shall record all system events including operator commands and shall be capable of providing a printed list of system conditions such as detector sensitivities, thresholds, analog voltages, device type, and custom message. The printer shall automatically perform a self test every 24 hours. A trouble condition shall be generated when printer paper has run out. An internal buffer shall continue to store events when paper is out.
  - d. The printer shall have at least 80 characters per line and capable of printing at 120 characters per second.
- H. Addressable Devices – General:
- 1. Addressable devices shall use simple to install and maintain decade (numbered 1 to 10) type address switches.
  - 2. Addressable devices which use a binary address setting method, such as a Dip switch, are difficult to install and subject to installation error. This type of device is not an allowable substitute.

3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the FACP signaling line circuit.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. Smoke detector sensitivity shall be set in the fire alarm control panel and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Class A applications.
8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. A magnetic test switch shall be provided to test each detector for 100 percent obscuration, reported to the FACP.
12. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100 percent of the alarm threshold.



- I. Addressable Pull Box (Manual Station):
  - 1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key. Manual pull stations shall be of the double action type.
  - 2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
  - 3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger.
  - 4. Stations shall be suitable for surface mounting or semiflush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor. Stations shall be provided with stopper covers.
  
- J. Intelligent Photoelectric Smoke Detector:
  - 1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
  
- K. Intelligent Thermal Detectors:
  - 1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees C) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit. Up to 99 intelligent heat detectors may connect to one SLC loop.
  
- L. Intelligent Duct Smoke Detector:
  - 1. The in-duct smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
  - 2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
  - 3. Label all concealed duct smoke locations with a red phenolic label on ceiling.
  - 4. Provide remote test stations for all duct smokes.
  
- M. Addressable Dry Contact Monitor Module:
  - 1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops.
  - 2. The monitor module shall mount in a 4-inch square, 2-1/8 inch deep electrical box.

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3. The IDC zone may be wired for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
  4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1-1/4 inch x 1/2 inch. This version need not include Style D or an LED.
- N. Two Wire Detector Monitor Module:
1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
  2. The two-wire monitor module shall mount in a 4 in. square, 2-1/8 in. deep electrical box or with an optional surface backbox.
  3. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
- O. Addressable Control Module:
1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.
  2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
  3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100 percent of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
  4. Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.
  5. The control module shall be suitable for pilot duty applications and rated for a minimum of .6 amps at 30 VDC.
- P. Isolator Module:
1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. At least one isolator module shall be provided for each floor or protected zone of the building.
  2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

3. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall mount in a standard 4-inch deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

Q. Carbon Monoxide Detector

1. Provide CO detector where indicated on drawing. Signal shall be supervisory to central station and identified as "CO Detector". The CO sensor base shall have removable CO element that can either work independently as a toxic gas detector or be combined with a photo or heat sensor to provide a method to reduce unnecessary alarms from common sources such as steam from showers, aerosols from personal care products, cooking materials, dust and exhaust fumes. The CO sensor base does not require a separate device be mounted onth wall or ceiling.
2. Certifications:
  - a. OSHA compliant CO gas sensing: CO condition level may be programmed by concentration to affect ventilation control.
  - b. UL listed – for both UL 2034 and 2075 applications.
  - c. Extended Life Span – 10 years of service.

R. Duct mounted carbon monoxide detector:

1. Manufactured by Air Products and Controls Model SL-701 or Equal
2. Product Specifications

<p>Voltages available:          APPROVALS</p>	<p>230VAC, 115VAC, 24VAC, 24VDC          Electrochemical Carbon Monoxide Sensor is a UL Recognized component in accordance with the requirements of UL2034. Also meets EN50291 requirements. SL-2000 Series Duct Smoke Detector Fire Alarm Certifications referenced side one:          UL &amp; CUL Listed (UL268A, UROX, UROX7) File # S2829 CSFM Listed (3240-1004:105); MEA Accepted (73-92-E, VOL. 27)</p>
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<p>SAMPLING TUBES Provide required length for duct coordinate with HVAC drawings          ACCESSORIES</p>	<p>Sectional sampling tube          Metal sampling tube for 6" to 2.5' duct width          Metal sampling tube for 2.5' to 5.0' duct width          Metal sampling tube for 5.0' to 10.0' duct width          MSR-50/CO remote accessory          TG-701 aerosol test gas          T-PB power supplies          WP-2000 weatherproof enclosure          (All available from Air Products and Controls Inc.)</p>
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POWER REQUIREMENTS	Input Power	Standby Current	Alarm
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			Current
24VAC	55mA		190mA
24VDC	14mA		68mA
115VAC	22mA		32mA
230VAC	12mA		18mA

**RELAY CONTACT RATING:**

Alarm Contacts	Resistive load: 2 sets form "C" rated at 10 Amps @ 115VAC
Trouble Contacts	Resistive load: 1 set form "A" rated at 2 Amps Resistive load: 1 set form "C" rated at 10 Amps @ 115VAC

AIR VELOCITY	100 to 4,000 ft. /min.
AMBIENT TEMPERATURE	32°F to 158°F (0°C to 70°C)
HUMIDITY	10% to 85% RH Non-Condensing / Non-Freezing
WIRING	Solid or stranded: #12 to #22 AWG terminals
MATERIAL	Grey plastic back box, clear plastic cover (Makrolon 94V-0)
	Do not expose to corrosive atmospheres.
DIMENSIONS	13 ½" L x 4 ½" W x 2 ¼" D
MAX. NET WT.:	2 ½ lbs.
HARDWARE	7" exhaust tube, FAST Tube starter sampling tube, sampling tube end cap, mounting template, and mounting hardware included.

S. LCD Alphanumeric Display Annunciator:

1. The alphanumeric display annunciator shall be a supervised, back-lit LCD display containing a minimum of 80 characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions from either the network node or complete network, via the INA.
3. Up to 32 LCD annunciators may be connected to a specific (terminal mode) EIA 485 interface. LCD annunciators shall not reduce the annunciation capacity of the system. Each LCD shall include vital system wide functions such as, system acknowledge, silence and reset.
4. LCD display annunciators shall mimic the local control panel 80 character display or network annunciator and shall not require special programming.
5. Annunciator shall provide all functions of the FACP. Provide a hand held microphone in the annunciator cabinet.

- T. Batteries and External Charger:
  - 1. Battery:
    - a. Batteries shall be 12 volt, Gell-Cell type.
    - b. The battery shall have sufficient capacity to power the fire alarm system for not less than 60 hours plus 10 minutes of alarm upon a normal AC power failure. Submit calculations of selected battery to Engineer for review.
    - c. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills and leakage shall not be required.
  
- U. Speaker/Strobe Units for Mass Notification application:
  - 1. One-way Tone/Voice Communication:
    - a. The evacuation alarm and alert signals shall be capable of being initiated automatically from the fire alarm control panel (FACP) and transmitted to any speaker circuit, selected speaker circuits or all speaker circuits.
    - b. The alarm signal, alert signal and live voice announcements shall be capable of manual transmission from the FACP to any speaker circuit, selected speaker circuits or all speaker circuits by manual selection of the associated speaker circuit control switches.
    - c. Live voice announcements, via the hand-held microphone or patched in external source, by use of speaker control switches, shall take priority over all previously activated alarm inputs. In addition to NFPA 72 requirements, the system shall be capable of priority live voice announcements over subsequent alarm conditions. In no case shall subsequent alarms disrupt emergency live voice announcements. Mass notification activation is the only condition allowed to override the fire alarm event.
    - d. Within the individual assembly occupancies in this project, an alarm received during a program occupancy shall sound an alert alarm at a constantly attended location and perform the following actions:
      - 1) Deliver a field programmable, digitized custom evacuation message to the occupants, detailing evacuation instructions.
      - 2) A simultaneous message shall be delivered via all alarm speakers installed in remainder of the building directing evacuation using exits other than the assembly occupancy exit path.
      - 3) Perform all control functions as detailed elsewhere in this specification
      - 4) An automatic announcement or tone evacuation signal shall be capable of interruption by the operation of the system microphone to give voice evacuation instructions overriding the pre-programmed sequences
    - e. Visual Unit (Xenon Strobe) unit:
      - 1) Provide yellow strobe (MNS event) Unit and include "ALERT" in white lettering.
  
- V. Locate mass notification strobes in walls near fire alarm strobes.

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- W. Power for mass notification strobes shall be through same field power supplies for fire alarm strobes.
  - X. Power for mass notification strobes shall be through field power supplies for fire alarm strobes. Provide grouped control modules at appliance circuit terminal boxes for control of mass notification strobes.
  - Y. Activation of mass notification system shall be through access control system via (2) contact closure.
  - Z. Speaker/Strobe Units:
    - 1. One-way Tone/Voice Communication:
      - a. The evacuation alarm and alert signals shall be capable of being initiated automatically from the fire alarm control panel (FACP) and transmitted to any speaker circuit, selected speaker circuits or all speaker circuits. Provide female voice to meet code.
      - b. The alarm signal, alert signal and live voice announcements shall be capable of manual transmission from the FACP to any speaker circuit, selected speaker circuits or all speaker circuits by manual selection of the associated speaker circuit control switches.
      - c. Live voice announcements, via the hand-held microphone or patched in warden phone, by use of speaker control switches, shall take priority over all previously activated alarm inputs. In addition to NFPA 72 requirements, the system shall be capable of priority live voice announcements over subsequent alarm conditions. In no case shall subsequent alarms disrupt emergency live voice announcements.
      - d. Alarm speaker amplification equipment shall be sized, as a minimum, to provide the following wattage levels for each location type of alarm speaker:
        - 1) Each floor alarm speaker: Provide one watt of input power.
        - 2) Each toilet alarm speaker: Provide one-half watt of input power.
        - 3) Each mechanical room alarm speaker: Provide two watts of input power.
        - 4) Each stairwell alarm speaker: Provide one-half watt of input power.
        - 5) Each elevator cab alarm speaker: Provide one-quarter watt of input power.
      - e. As a minimum, alarm speaker amplification equipment shall be sized to provide the above indicated wattage of input power to each location type of alarm speaker shown on the Drawings, plus 25 percent spare capacity to permit the addition of future alarm speakers.
      - f. Alarm speaker amplifiers shall be paired to provide 100 percent redundancy. One back-up alarm speaker amplifier shall be provided for each primary alarm speaker amplifier. If any primary alarm speaker amplifier fails, its function shall be taken over by its backup amplifier. Provide dedicated power amplifiers for each speaker circuit (minimum of four) with one dedicated backup.
      - g. Alarm tone and alert tone oscillators and pre-amplifiers shall be paired to provide 100 percent redundancy.

- h. As a minimum, each stairwell shall be provided with a dedicated notification appliance circuit.
  - i. As a minimum, the system shall be configured as a two channel voice system.
  - j. Within the individual assembly occupancies in this project, an alarm received during a program occupancy shall sound an alert alarm at a constantly attended location and perform the following actions:
    - 1) Deliver a field programmable, digitized custom evacuation message to the occupants, detailing evacuation instructions.
    - 2) A simultaneous message shall be delivered via all alarm speakers installed in remainder of the building directing evacuation using exits other than the assembly occupancy exit path.
    - 3) Perform all control functions as detailed elsewhere in this specification
    - 4) An automatic announcement or tone evacuation signal shall be capable of interruption by the operation of the system microphone to give voice evacuation instructions overriding the pre-programmed sequences
  - k. Visual Unit (Xenon Strobe):
    - 1) Combination speaker strobe units - Provide Truealert Non-Addressable 75 Cd, Red Sync. 2-Wire. Comprised of a 24 VDC Xenon Flash Tube entirely solid state. The unit shall require a sync. Control module. Provide True 75 Cd from all axis. Provide white finish.
    - 2) Combination speaker strobe units - Provide Truealert Non-Addressable 110 Cd, Red Sync. 2-Wire. Comprised of a 24 VDC Xenon Flash Tube entirely solid state. The unit shall require a sync. Control module. Provide True 110 Cd from all axis. Provide white finish.
    - 3) Visual only – Provide Truealert Non-Addressable 15 Cd, Red Sync. 2-Wire comprised of a 24 VDC Xenon flash tube entirely solid state. Provide white finish.
- AA. Digital Communicator:
- 1. Provide UL listed digital communicator to transmit signal to fire department via two (2) dedicated telephone lines. Provide CAT 5 telephone cable in ¾" C to telephone demarcation backboard.
- BB. Exterior Strobe-unit:
- 1. Provide wall mounted, 24 VDL strobe, color red with WRR wall bracket.
- CC. Provide clear plastic covers without local audible alarm for pull stations in gym. Provide clear plastic covers with audible at all other Manual Pull stations.
- DD. Magnetic Door Holders:
- 1. Provide under hardware Section 087100 and installed and wired by Electrical Contractor.

- EE. Key Repository Box:
1. Provide a key repository box (es) in accordance with fire department requirements.
- FF. Graphic Map: Provide graphic map to the fire department and engineer for review and approval.
- GG. Field Quality Control
1. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
  2. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
    - a. Factory trained and certified.
    - b. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
    - c. International Municipal Signal Association (IMSA) fire alarm certified.
    - d. Certified by a state or local authority.
    - e. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
  3. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
  4. Final Test Notice: Provide a ten-day minimum notice in writing when the system is ready for final acceptance testing.
  5. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72. Provide 2 year service contract to perform NFPA 72 required testing.
  6. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
  7. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.
  8. Provide a point list with address devices to be reviewed and approved by the fire department and engineer prior to programming the system.
  9. Perform Db level testing prior to fire department test.
  10. Final Test, Certificate of Completion, and Certificate of Occupancy:
    - a. Test the entire system 100 percent devices in accordance with the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Prior to that, and as a requisite, a separate test will be witnessed by the Engineer of Record.



11. Engage a factory-authorized service representative to train Owner's maintenance personnel and building supervisors to adjust, operate, utilize, troubleshoot, conduct software installation, and maintain the fire alarm control panel and fire command center. Provide eight (8) five hour training sessions for Owner's personnel. Training shall be held on site in classroom. Manufacturer shall professionally video record training by Factory Personnel and provide media to Owner. Provide a hard copy of manuals, instructional videos, and recorded training session(s) on CD or DVD.

## 2.19 SURGE PROTECTION DEVICES

### A. Scope

1. This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all main service and panelboards.

### B. Submittals

1. Submit shop drawings and product information for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location, and customer order number.
2. Submittals shall include UL 1449 3rd Edition Listing documentation verifiable by visiting [www.UL.com](http://www.UL.com), clicking "Certifications" link, searching using UL Category Code: VZCA and VZCA2:
  - a. Short Circuit Current Rating (SCCR)
  - b. Voltage Protection Ratings (VPRs) for all modes
  - c. Maximum Continuous Operating Voltage rating (MCOV)
  - d. I-nominal rating (I-n)
  - e. SPD shall be UL listed and labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications
3. Upon request, an unencapsulated but complete SPD formally known as TVSS shall be presented for visual inspection.
4. Minimum of ten year warranty

### C. Related Standards

1. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,
2. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits,
3. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
4. National Electrical Code: Article 285
5. UL 1283 - Electromagnetic Interference Filters
6. UL 1449, Third Edition, effective September 29, 2009 – Surge Protective Devices

- D. Quality Assurance
  - 1. Manufacturer Qualifications: Engage a firm with at least five years experience in manufacturing transient voltage surge suppressors.
  - 2. Manufacturer shall be ISO 9001 or 9002 certified.
  - 3. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
  - 4. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.
  
- E. Delivery, Storage and Handling
  - 1. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One copy of this document to be provided with the equipment at time of shipment.
  
- F. Manufacturers
  - 1. Provide an internally mounted Surge Protective Devices (SPD) formerly called Transient Voltage Suppressor (TVSS) by:
    - a. Siemens Industry.
    - b. Current Technology
    - c. LEA
    - d. Liebert
    - e. APT
    - f. Cutler Hammer
    - g. Or equal
  
- G. Electrical Distribution Equipment
  - 1. Service Entrance
    - a. SPD shall be UL 1449 labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
    - b. SPD shall be factory installed integral to electrical distribution equipment.
    - c. SPD shall be UL labeled with 20kA I-nominal (I-n)
    - d. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).
    - e. Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.

- f. True 10 Mode Protection paths: SPD shall provide “directly connected protection elements” between all possible modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
- g. SPD shall be connected external of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
- h. SPD shall meet or exceed the following criteria:
  - 1) Maximum 7-Mode surge current capability shall be [300kA] [400kA] [500kA] per phase.
  - 2) Maximum 10-Mode surge current capability shall be [300kA] [450kA] per phase.
  - 3) UL 1449 - Third Edition Revision; effective September 29, 2009 Voltage Protection Ratings shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>	<u>MCOV</u>
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

- i. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

<u>System Voltage</u>	<u>Allowable System Voltage Fluctuation (percent)</u>	<u>MCOV</u>
208Y/120	25 percent	150V
480Y/277	15 percent	320V

- j. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.
- k. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
- l. SPD shall include a serviceable, replaceable module.
- m. SPD shall be equipped with the following diagnostics:
  - 1) Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
  - 2) Audible alarm with on/off silence function and diagnostic test function (excluding branch).
  - 3) Form C dry contacts
  - 4) Optional – Surge Counter
  - 5) No other test equipment shall be required for SPD monitoring or testing before or after installation.
- n. SPD shall have a response time no greater than 1/2 nanosecond.
- o. SPD shall have a 10 year warranty.

2. Distribution Panel

- a. SPD shall be UL 1449 labeled as Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
- b. SPD shall be factory installed integral to electrical distribution equipment.
- c. SPD shall be UL labeled with 20kA I-nominal (I-n)
- d. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).
- e. Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
- f. SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
- g. SPD shall meet or exceed the following criteria:
  - 1. Maximum 7-Mode surge current capability shall be 100kA per phase.
  - 2. Maximum 10-Mode surge current capability shall be 150kA per phase.
  - 3. UL 1449 - Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:
- h. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>	<u>MCOV</u>
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

<u>System Voltage</u>	<u>Allowable System Voltage Fluctuation (percent)</u>	<u>MCOV</u>
208Y/120	25 percent	150V
480Y/277	15 percent	320V

- i. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.
- j. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
- k. SPD shall include a serviceable, replaceable module.
- l. SPD shall be equipped with the following diagnostics:
  - 1) Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
  - 2) Audible alarm with on/off silence function and diagnostic test function (excluding branch).
  - 3) Form C dry contacts
  - 4) Optional – Surge Counter

- 5) No other test equipment shall be required for SPD monitoring or testing before or after installation.
- m. SPD shall have a response time no greater than 1/2 nanosecond.
- n. SPD shall have a ten year warranty.
3. Branch Panels
- a. The panelboard shall be UL 67 Listed and the SPD shall be UL 1449 labeled as Type 1 or as Type 4 intended for Type 1 or Type 2 applications.
- b. The unit shall be top or bottom feed according to requirements. A circuit directory shall be located inside the door.
- c. SPD shall meet or exceed the following criteria:
- 1) Maximum 7-Mode surge current capability shall be 100kA per phase.
  - 2) Maximum 10-Mode surge current capability shall be 150kA per phase.
  - 3) UL 1449 - Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>	<u>MCOV</u>
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V
- d. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):
- | <u>System Voltage</u> | <u>Allowable System Voltage Fluctuation (percent)</u> | <u>MCOV</u> |
|-----------------------|---|-------------|
| 208Y/120              | 25 percent  | 150V        |
| 480Y/347              | 15 percent  | 320V        |
- e. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.
- f. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
- g. SPD shall include a serviceable, replaceable module.
- h. SPD shall be equipped with the following diagnostics:
- 1) Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
  - 2) Audible alarm with on/off silence function and diagnostic test function (excluding branch).
  - 3) Form C dry contacts
  - 4) Optional – Surge Counter
  - 5) No other test equipment shall be required for SPD monitoring or testing before or after installation.
- i. SPD shall have a response time no greater than 1/2 nanosecond.
- j. SPD shall have a 10 year warranty.
- k. The unit shall have removable interior.
- l. The main bus shall be copper and rated for the load current required.

- m. The unit shall include a 200 percent rated neutral assembly with copper neutral bus.
- n. The unit shall be provided with a safety ground bus.
- o. The field connections to the panelboard shall be main lug or main breaker.
- p. The unit shall be constructed with flush or surface mounted trim and shall be in a NEMA Type 1 enclosure.

H. Installation

- 1. Install per manufacturer's recommendations and contract documents.

I. Adjustments and Cleaning

- 1. Remove debris from installation site and wipe dust and dirt from all components.
- 2. Repaint marred and scratched surfaces with touch up paint to match original finish.

J. Testing

- 1. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacturer's recommendations.
- 2. Check all installed panels for proper grounding, fastening and alignment.

K. Warranty

- 1. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of substantial completion operation.

2.20 LADDER TRAY/WIREWAYS

- A. Provide aluminum ladder tray with 6 in. rung spacing with 4 in. side rail. Ladder tray shall be as manufactured by B-Line. "Ladder Type". Provide all hangers required. The width of the ladder tray shall be as indicated on drawings.

- 1. Acceptable Manufacturers:
  - a. B-Line
  - b. Chalfant
  - c. Chatsworth
  - d. PW Industries
  - e. Or equal

- B. Provide wireways for power and data where shown on drawings.

- 1. This specification covers NEMA type 1 wireway used to house and protect communication cable. The wireway system shall consist of wireway and appropriate fittings to complete the installation per the electrical drawings.

2. Metal wireway (NEMA type 1) is to be utilized in dry interior locations only as covered in article 362 part a of the national electrical code, as adopted by the national fire protection association and as approved by the American National Standards Institute. The wiremold "c" or "sp" series is listed by underwriters' laboratories under file no. E137690 guide zoyx.
3. The wireway system specified herein shall be manufactured by the MP Husky. The size of the cable maximum of 40% fill is allowed.
  - a. Acceptable Manufacturers:
    - 1) MP Husky
    - 2) Wiremold Company
    - 3) Hoffman
    - 4) Or equal
4. The wireway and all system components must be UL Listed in full compliance with their standard UL870, "electrical wireways, auxiliary gutters and associated fittings". It shall be manufactured from 16-gauge cold rolled steel, finished in ASA 61 gray powder coat paint. All sizes larger than 6 in. x 6 in. shall be manufactured from 14-gauge cold rolled steel, finished in ASA 61 gray powder coat paint. A factory installed divider shall be available to separate power and low voltage wiring housed in the same wireway sections.
5. A full complement of fittings for the raceway shall be available including, but not limited to, 45° and 90° flat, vertical inside and outside elbows, tee and cross fittings, couplings for joining sections of wireway, reducers, hangers, end blanks, a field installed divider and all other components necessary to make the system workable. The fittings shall have an ASA 61 gray powder coat paint finish to match the wireway.
6. Prior to and during installation, refer to system layout drawing containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets which accompany system components as well as complete system instruction sheets, whichever is applicable.
7. All wireway systems shall be mechanically continuous and connected to all electrical boxes and cabinets, in accordance with manufacturer's installation sheets.
8. All connections shall be checked to make sure they are correctly tightened and to insure that all wireway shall be electrically continuous and bonded in accordance with the national electric code for proper grounding.
9. All wireway systems shall be installed complete. Work shall include fastening all wireway and appropriate fittings to install a complete wireway system as indicated on the electrical and/or communication drawings and in the applicable specifications

## 2.21 SEALS

### A. Water Tight Seals:

1. Conduits entering from the exterior or below grade shall have water tight fittings on the outside and on the inside of the conduit.
  - a. Fittings on the outside of the conduit shall be O-Z Gedney type FSK or approved equal. Provide type WSK if penetration is within two feet of the high water table. Provide grounding attachment.

- b. Fittings on the inside of the conduit shall be O-Z Gedney type CSBI or approved equal. Provide type CSBG if penetration is within two feet of the high water table. Provide a blank fitting to seal spare or empty conduits.
      - c. O-Z Gedney type CSM fitting may be used when sealing within a sleeve or cored hole.
    - 2. Submit on seals to be used.
  - B. Environmental Seals:
    - 1. Provide seals on raceways exposed to widely different temperatures, as in refrigerating or cold storage areas. Install seal to prevent circulation of air from warmer to colder sections through the raceway.
  - C. Hazardous Area Seals:
    - 1. Provide explosion proof seals required by the Electric Code for the following areas.
      - a. Explosion proof exhaust fans.
  - D. Smoke and Fire Stopping Seals:
    - 1. All work shall be in accordance with the requirements of Section 078400.
- 2.22 UNDERGROUND DUCTBANKS
  - A. General: Furnish and install the ductbanks as herein specified and as shown on drawings.
  - B. Division of Work:
    - 1. The General Contractor shall be responsible for the work and material required for the following:
      - a. Excavation
      - b. Backfill
      - c. Installation of handholes/manholes
      - d. Brick or concrete collars to bring handhole frames and covers up to grade. Installation of frames and collars which are to be furnished by the Electrical Subcontractor.
      - e. Concrete Encasement
    - 2. All other material, equipment, and labor required for the complete ductbank shall be furnished and installed by the Electrical Subcontractor under this Section, including the following:
      - a. Service raceways.
      - b. Grounding material.
      - c. Ductbank warning tape.
      - d. Furnishing pre-cast handholes/manholes.
      - e. Conduit spacers.



C. Materials:

1. Conduit: UL listed, schedule 40 PVC in accordance with NEMA standard TC-2.  
See BASIC MATERIALS SECTION.
2. Conduit Supports (duct system): Shall be molded plastic with interlocking lugs and skeletonized structure, minimum separation 3 in.
3. Tags: Non-ferrous metal or fibre, 1/4 in. high letters.
4. Warning tape shall be yellow polyethylene 4 mil thick, 6 in. wide terratape, similar to REEF Industries, Houston, Texas and shall be installed above all ductbanks both high and low tension.

D. Duct System:

1. The duct system shall consist of Schedule 40 PVC conduit except where otherwise specified. The size and number of conduits shall be as indicated on the drawings. Provide a pull wire in each conduit.
2. The entire length between handholes and end of ductbank shall be excavated and graded before any conduit is laid.
3. The ductbank shall be set on undisturbed earth.
4. The conduit shall be installed so that top is a minimum of 36 in. below finished grade unless otherwise indicated, and shall be laid to a minimum grade of 4 in. for each 100 feet of length. Duct system shall drain to manholes/handholes.
5. Changes in direction shall be made by long sweep bends, minimum radius 25 feet except that at the end of a run, within ten feet of termination. Manufactured ends may be used having a minimum radius of 36 inches.
6. Conduit base and intermediate spacers shall be installed a maximum of 5 feet on centers. Spacers shall not be placed one above the other, but shall be staggered a minimum of 6 in..
7. All conduit joints shall be made watertight by means of a sealing compound before the coupling is installed. Joints in conduit shall be staggered, minimum space between joints in adjacent conduit shall be 6 inches.
8. When the required number of conduits have been installed, securely tie the assembly together at distances not exceeding 7 ft. Tie shall consist of three turns of No. 18 iron wire. Separate ties required for low tension and high tension conduit runs.
9. Duct envelope shall be vibrated to eliminate voids.
10. Ductbanks shall not be covered until the conduit installation has been observed by the utility company and Architect.
11. Warning tape shall be installed during backfilling and shall be placed approximately 12 in. above the conduits.
12. After the installation is completed, each conduit shall be cleaned and identified. A standard flexible mandrel and a stiff bristle brush shall be pulled through each conduit. The mandrel shall not be less than 12 in. long and the diameter approximately 1/4 in. less than the conduit.

## 2.23 STANDBY ELECTRICAL SYSTEM

- A. Provide one 300 kW, 375 kVA at .8 PF standby power rated natural gas fueled generator set, mounted in perfect alignment on an all welded, fabricated steel sub-base which shall allow for attachment of all necessary engine and generator accessories.
1. Acceptable Manufacturers:
    - a. Kohler
    - b. Caterpillar
    - c. Onan/Cummings
    - d. Generac
    - e. MTU Onsite Energy
    - f. Or equal
- B. Engine
1. Water cooled with unit-mounted radiator. Provide starter and all field wiring required by manufacturer
  2. Dry-type replaceable element air cleaners.
  3. Full flow lube oil filters and bypass oil filter.
  4. Twelve volt starting motor, 12 volt, 3 ampere battery charging alternator.
  5. Engine instrument panel to include ammeter, lube oil pressure gauge, lube oil temperature gauge, water temperature gauge, and hour meter.
  6. Engine-mounted safety control to provide alarm signals for engine shutdown in event of low oil pressure, high coolant temperature, over speed, over crank, and pre-alarms for high water temperature and low oil pressure.
  7. Jacket water heater, 2000 watt, 120 or 208 volt, single phase or as recommended by generator manufacturer.
- C. Generator: 300 kW, 375 kVA, 277/480 volt, 3 phase, 4 wire, 60 Hz, 1800 RPM revolving field type main generator with brushless exciter and permanent magnet.
- Voltage regulation  $\pm$  1 percent from no load to full load.
- D. Cooling System: Unit mounted radiator with flange attached.
- E. Starting System: 12 volt heavy duty lead acid storage battery, connected for 12 volt DC output.
- F. Battery rack, cables, and connectors shall be provided.
- G. Provide 10 amp battery charger fed from a 120 volt, single phase, 60 Hz service. Battery charger to include high and low battery voltage alarm relays for derangement panel. Battery charger shall meet NFPA 110 Standards.
- H. Exhaust System: Furnish one Maxim M-51 3 in. critical silencer, 3 in. side inlet, and one 3 in. end outlet complete with two, 3 in. companion flanges. Furnish one 3 in. x 18 in. flexible stainless steel exhaust connector, flanged on one end, threaded nipple on opposite end. Generator shall meet all applicable emission standards.

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- I. Vibration Isolators: Set of four Korfund rubber type vibration isolators for installation between steel base and concrete foundation.
- J. Generator Control Panel:
1. To completely control operation of engine generator set. Panel to have automatic start control, AC volt meter, AC ammeter, pointer type frequency meter, volt meter, ammeter and selector switch. Alarm signals to indicate pre-low oil pressure, pre-high coolant temperature, and alarm signals to shut down engine in event of a low oil pressure, high coolant temperature, engine over speed, or over crank. Lights on face of panel to indicate failure. Provide dry contacts for remote disarrangement signal and louvers. Locate remote annunciator in administration area.
  2. Terminal strip shall be included with alarms and prewarning devices prewired for remote annunciator specified herein. Provide wiring between generator and remote annunciator panel. Generator control switch shall be mounted on control panel face. A flashing light for selector switch "OFF" shall be included.
  3. Provide molded case line circuit breakers mounted on generator in oversized terminal box.
  4. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
    - a. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
    - b. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.
    - c. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
    - d. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
    - e. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
- K. Automatic Transfer Switches:
1. Provide automatic transfer switches as shown on drawings for operation on 277/480 volts, 3 phase, 4 wire operation. Units to be housed in a NEMA 1 enclosure and shall be 4 pole. Transfer switches over 400 amperes shall have an AIC rating of 65,000 ARMS.
  2. Transfer switches 400 amperes or less shall be rated for 42,000 ARMS and fed from a current limiting breaker on the normal side.

3. Entire switch shall be listed under UL 1008.
  - a. Acceptable Manufacturers:
    - 1) Russ Electric
    - 2) ASCO
    - 3) Kohler
    - 4) Or equal
4. Unit shall be provided with standard accessories as follows.
  - a. Voltage and Frequency Sensing:
5. Close differential voltage sensing on all phases of normal pickup adjustable 85-100 percent. Dropout 75-98 percent
6. Voltage sensing of emergency source. Adjustable pickup 85-100 percent.
7. Frequency sensing of emergency source. Adjustable pickup 90-100 percent.
  - a. Time Delays:
8. Time delay to override momentary normal source outages. Adjustable 0.5 to 6 seconds.
9. Retransfer to normal with 5 minute cooldown timer.
  - a. Engine Control:
10. Contact to close when normal source fails.
11. Contact to open when normal source fails.
12. Test switch to simulate normal source failure.
  - a. Indicators: Pilot lights to indicate switch in normal position or emergency position.
  - b. Auxiliary Contacts: Two to close on normal. Two to close on emergency.
13. Optional Accessories:
  - a. Plant exerciser.
  - b. In-phase monitor (Motor Load Transfer). (ATS-OS)
  - c. Manual transfer to normal source.
  - d. Elevator control transfer module. A load control circuit consists of two sets of single pole, double throw contacts that operate 3 seconds before transfer in either direction. Contacts rated 3 amperes, 208 volts AC or 10 amperes, 32 VDC, for signal to elevator of generator power available. Provide 2 #14AWG conductors in 3/4 in. conduit, interlock wiring to each elevator controller from each switch controlling elevator power.
  - e. Engine Start control and Monitoring
    - 1) The Engine Start Control and Monitoring Modules shall be ASCO 5101 Engine Start Modules or equal. The solution must cover and provide complete compliance to the 2017 NEC 700.10 code.

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- 2) The ATS shall provide continuous monitoring of the entire remote start circuit. Visual and audible annunciation of generator malfunction shall be initiated if the integrity of the start circuit is compromised.
  - 3) There shall be minimum time delay (less than 5 seconds) in annunciation of any compromised condition such as an open or short circuit. A system which annunciates compromised conditions only after a generator start signal is initiated via a redundant path does not meet the intent of this specification.
  - 4) The detection of a compromised start circuit shall initiate and latch the generator start circuit.
  - 5) Each Generator Engine Start Module shall be din-rail mounted and accept up to (8) ATS Engine Start. Each channel must have its own dedicated tri-colored status LED.
  - 6) Each Engine Start channel must have its own dedicated switch with ability to enable or disable monitoring function.
  - 7) Engine-start circuit shall be a single pair of typical hardwire used in legacy applications. Additional wiring and components beyond specified herein does not meet the intent of this specification.
14. Coordinate placement of required components within the generator controls with the specified manufacturers.
- 1) Provide a communication port to interface with the building management system for transmitting the generator set status and alarms data including alarm on a generator set failure to start automatic weekly exercise.
  - 2) Supports industry-standard Modbus\_RTU protocol.
  - 3) Uses either an RS-232 or RS-485 Network port.
  - 4) Communicates at baud rates up to 19200.
  - 5) Allows selection of an access code for remote programming.
  - 6) Remotely monitors system operation including run times, shutdowns, warnings, and input/output activity.
  - 7) Allows selection of either metric (SI) or English (IP) units.
  - 8) Provides more than 100 different Modbus\_message codes for system monitoring, including System Ready and Generator Running.
  - 9) Provides remote programming of most system parameters including time delays, trip points, voltage, frequency, and current.
  - 10) Allows remote engine start/stop and controller reset.
- L. Roll-up Generator Manual Transfer Switch
1. Furnish and install manual transfer switches (3MTS) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each manual transfer shall consist of a 3 position center off mechanically held power transfer switch unit and a mechanical operating mechanism to provide complete manual operation. All transfer switches and mechanical operating mechanism shall be the product of the same manufacturer.
  2. Acceptable Manufacturers:
    - a. ASCO Series 300 (3MTS)

- b. ESL
  - c. Eaton
  - d. Or equal
3. Codes and Standards: The manual transfer switches and accessories shall conform to the requirements of:
- a. UL 1008 Listed for Optional Standby Transfer Switches (Manual Transfer Switches)
  - b. CSA C22.2 No.178 – 1978
  - c. IEC 60947-6-1 Low – Voltage Switchgear and Controller
  - d. NFPA 70 - National Electrical Code
  - e. NFPA 99 – Essential Electrical Systems for Health Care Facilities
  - f. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby
  - g. Power Systems for Commercial and Industrial Applications
  - h. UL 508 Industrial Control Equipment
  - i. NEC Article 700.3 (F)
  - j. International Standards Organization ISO 9001:2008
  - k. RoHs compliant (Restriction of Hazardous Substances)
  - l. Seismic qualification – International Building Code & OSHPD to SDS level of 2.5
4. Mechanically Held Transfer Switch
- a. The transfer switch unit shall be manually operated and mechanically held. The switch shall be mechanically interlocked to ensure only one of three possible positions, Source 1, Source 2, or Center Off. Fused disconnect type switches shall not be acceptable.
  - b. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
  - c. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.
  - d. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors.
  - e. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
  - f. Where neutral conductors must be switched, the MTS shall be provided with fully-rated neutral transfer contacts.
  - g. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

- h. The MTS shall be tested in accordance with UL 1008 for transfer switches. Switch ratings of 260 amperes and less shall have endurance rating of 6000 cycles, 400 ampere shall have endurance rating of 4000 cycles, and 600 – 1200 ampere shall have endurance rating of 3000 cycles.
5. Manual Operations Provisions
- a. The transfer switch shall be arranged for manually actuated manual operation.
  - b. The manual transfer shall be actuated via a mechanical operating mechanism.
  - c. The manual operating handle shall be capable of external operation without opening the enclosure door.
  - d. It shall have the same contact to contact speed as automatic operation
  - e. There shall be three positions for manual operation:
    - 1) Connected to Source 1 (preferred)
    - 2) Connected to Source 2 (alternate)
    - 3) Connected to center off (disconnected position)
  - f. Switch position when connected to Source 1, or Source 2 shall be pad - lockable
6. Enclosure:
- a. The 3MTS shall be furnished in a NEMA type 3R enclosure unless otherwise shown on the plans.
  - b. Enclosures shall be free standing, floor mounted.
  - c. Enclosures shall be code gauge steel as per UL 50 with ANSI #61 powder coat finish.
  - d. Outdoor enclosures shall be available in 316 stainless steel
  - e. Provide strip heater with thermostat for Type 3R enclosure requirements.
7. Additional Features:
- a. Mechanical position indicators (yellow) visible to the operator shall be included for Source 1 (preferred), Source 2, (alternate), and Center Off (disconnected).
  - b. Optional LED indicators shall be available for Source 1 (preferred), and Source 2 (alternate).
  - c. Auxiliary position indicating contacts, rated 10 amps, 250 Vac shall be provided consisting of one closed when the MTS is connected to Source 1 (preferred), and one contact closed when the MTS is connected to Source 2 (alternate)
  - d. A form A contact shall be provided to indicate switch is in the Center Off (disconnected) position.
8. Accessories:
- a. Enclosure Heater(s)
    - 1) A 120v strip heater with thermostat and terminal block shall be provided for outdoor installations where type 3R, 4, enclosures are specified. External 120v power source required.

- 2) A 125 watt enclosure heater with transformer and thermostat (adjustable from 30° to 140 ° F) shall be provided for outdoor installations where type 3R, 4, enclosures are specified.
- b. Surge Suppression – A TVSS with a surge current rating of 65kA shall be provided with individually matched fused metal oxide varistors (MOVs). It shall include LED status indication of normal operation, under voltage, power loss, phase loss or component failure. Shall include form C dry contacts for external alarm or monitoring. The unit shall be enclosed in a Noryl housing rated NEMA 4, 12, and 4X. Shall comply with UL 1449 3rd edition. (This feature shall be equal to ASCO accessory 73).
- c. Auxiliary Contacts - Position indicating contacts, rated 10 amps, 250 Vac shall be provided consisting of two closed when the MTS is connected to Source 1 (preferred), and two contact closed when the MTS is connected to Source 2 (alternate). (This feature shall be equal to ASCO accessory 14AA/14BA).
- d. Accessory 170 Base Package Bundle – Two form C contacts shall be connected to customer terminal block that operate when Source 1 and Source 2 voltage is present at transfer switch terminals. The following indicators shall be provided:
  - 1) Load Connected to Source 1 (Green).
  - 2) Load Connected to Source 2 (Red).
  - 3) Source 1 Available (Green).
  - 4) Source 2 Available (Red).
  - 5) Load Disconnect (Yellow)
  - 6) Phase rotation monitor



See table below for other accessory 170 configurations (shall include base package bundle)

	Source Available/Connected to/Disconnected LEDs & Contacts	Phase Rotation Monitor	Maintained Engine Start Switch & Common Alarm LED/Contact	Keyed Maintained Engine Start Switch & Common Alarm LED/Contact	IO Module
170B	X				
170E	X		X		
170K	X			X	
170B1	X				X
170E1	X		X		X
170K1	X			X	X
170BP	X	X			
170EP	X	X	X		
170KP	X	X		X	
170BP1	X	X			X
170EP1	X	X	X		X

9. Withstand and Closing Ratings

- a. The MTS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the MTS terminals with the type of overcurrent protection shown on the plans. WCR MTS ratings @ 480v shall be as follows when used with specific circuit breakers or current limiting fuses:

MTS Size	Withstand & Closing Rating MCCB	W/CLF
150 - 600	50,000A	200,000
800 - 1200	65,000A	200,000

10. Tests and Certification

- a. The complete MTS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure compliance with the specification requirements.
- b. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

- c. The MTS manufacturer shall be certified to ISO 9001: 2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2008.
- 11. Service Representation
  - a. The MTS manufacturer shall maintain a national service organization of company- employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
  - b. The manufacturer shall maintain records of switch shipments, by serial number, for a minimum of 20 years.
  - c. For ease of maintenance, the transfer switch nameplate shall include drawing numbers and serviceable part numbers.
- M. Remote Annunciator Panel: A flush mounted panel shall include a visual signal that battery charger is functioning properly and both audible and visual signals. Annunciator shall meet NFPA 110 Standards.
- N. Audible signal shall have a silencing switch. A lamp test button shall be provided.
- O. Provide load bank test in the field by a factory certified representative for two hours at 25 percent, 50 percent, 75 percent and 100 percent load for 30 minutes at each stage and provide testing documentation. Also, provide a two hour building load test transferring the ATS switches to generator power. Provide an NFPA 110 test report for Engineer approval.
- P. Miscellaneous: Necessary lube oil and anti-freeze.
- Q. Equipment Testing and Instruction Manual and Drawings:
  - 1. Operating instructions and maintenance manuals shall contain the following information:
    - Operating Instructions
    - Replacement Parts
    - Wiring Diagram
    - Maintenance
  - 2. The entire emergency system shall be field test operated for two hours. A normal power failure shall be simulated. The engine generator unit shall automatically start, come up to speed, and assume full emergency load. Entire building shall be in operation during test.
  - 3. Custodians of the equipment shall be present during test. At that time they shall be instructed in operation and maintenance.
  - 4. Upon completion of tests, written reports containing results shall be submitted. Test reports shall contain readings taken at 30 minute intervals along with all other pertinent test information.
    - Ambient Temperature
    - Oil Pressure
    - Battery Charge Rate
    - AC Volts

AC Amperes All Phases  
Frequency  
Kilowatts  
Power Factor

R. Coordination of Trades:

1. The following equipment shall be furnished by Electrical Contractor but shall be installed under other sections.
  - a. Anchor bolts to be installed by General Contractor based on approved shop drawings.

S. Generator Outdoor Housing

1. The engine generating set shall be factory installed in a weatherproof outdoor housing. The housing shall provide year round generating set protection against adverse weather and environmental conditions. The enclosure shall be sound attenuated and meet Federal Specifications.
2. The weatherproof shelter shall be constructed or welded and bolted of reinforced aluminum, 14 gauge walls and 14 gauge floor plate. All metal parts shall be prime coated and finished painted.
3. The shelter assembly shall have shuttered air openings on front and sides with mesh screens covering side shutters. The air shutters shall be opened by four 22 volt AC motors when the generating set operates. Motors shall be spring loaded to close shutters when set stops.
4. Hinged double doors on each side and one door in rear of the shelter shall allow easy access to engine generator and controls. All door handles shall be key lock design.
5. Vibration isolators of the open coil spring type, selected for 3 inch (76mm) static deflection, shall be furnished and installed. The number of isolators shall be as recommended by the generator set manufacturer, and complete details shall be included in the Submittals. Anchor bolts, nuts and sleeves shall be supplied with recommended Foundation Plan.
6. The weatherproof housing shall allow installation of the silencer outside or inside the enclosure. Provide critical type silencer.
7. Provide sound deadening materials, baffles, and hoods to reduce noise levels to 75DBA at 7 meters in any direction.
8. Furnish a stainless steel 10' stack exhaust extension supported from the generator housing with rain cap and all necessary components for a complete installation in accordance with Commonwealth of Massachusetts regulations. Stack shall be powder coated with black heat resistant paint

## 2.24 LIGHTNING PREVENTOR SYSTEM

- A. Provide all labor, material, equipment, and services to perform all operations required for the complete installation and related work as specified herein and indicated on drawings for the early Streamer Emission System.

Any such work included in any other section of these specifications that is not specifically described therein shall comply with the requirements of this section.

The following items of work are specifically included in, but not necessarily limited to, the work of this section without limiting the generality implied by these specifications:

1. ESE lightning protection air terminal
2. Mast, complete with base and supports
3. Down conductors
4. Grounds
5. Surge Protective Devices

B. Submittals

1. Provide shop drawings showing location of ESE air terminal, mast conductors, installation procedures and details. Detailed manufacturer's data sheets on all components, accessories and miscellaneous equipment to be used in the installation shall also be submitted.
2. One complete set of independent performance testing documents on the ESE air terminal system shall be submitted to show compliance with the protection area of the unit submitted for the installation.

C. Description of System

1. The ESE installer shall provide a complete installation of equipment to comprise a complete system against damage by lightning. The ESE installer shall be responsible for all material and labor to accomplish this result.
2. The system, including the ESE air terminal, conductors, mast and complementary parts, shall be installed so that completed work is unobtrusive and does not detract from the building appearance.

D. Codes, Regulations, Permits

1. The completed system shall comply with the ESE manufacturer's standard, equipment supplier drawings and specification requirements for installation of ESE lightning protection systems.

E. Standards of Quality

1. The ESE system equipment supplier, contractor, and installer shall install the ESE system in compliance with the ESE Manufacturer's Standard.
2. The ESE system and manufacturer's guarantees and warranties shall be submitted to the owner upon completion of the ESE system installation.

F. Service and Testing

1. Installation of equipment shall be done under the direct supervision of a manufacturer and per the manufacturer's requirements.
2. The lightning protection installing contractor shall provide photos and/or video of the installation, including but not limited to, mast mounting, bonding connections (waterline and structural steel), down conductors, ground rods/grids and all buried, concealed or inaccessible connections and components. This information shall be forwarded to the ESE manufacturer for evaluation, certification, archiving and documentation.
3. The ground resistance of the completed system shall be measured using IEEE "Fall of Potential Method" in the presence of the Architect/Engineer and shall be forwarded to the ESE manufacturer. Ground resistance shall be ten (10) Ohms or less.

G. ESE Air Terminal

1. The complete assembly shall consist of: 5/8 in. air terminal which is HD 29 CU and heavy chrome plated 24 CH; lock nut and washer of chrome plated copper; support structure of chrome plated soft copper; and sphere shall be threaded to air terminal. The base of the ESE air terminal shall be threaded for interconnection to top of mast.

H. Conductors

1. Copper conductors shall be 28 strands of 14-gauge wire rope lay, with a net weight of 375 pounds per 1,000 feet (60mm<sup>2</sup>), minimum.
2. The structural steel may be utilized as main conductor if the steel is electrically continuous or is made so via other means. Every other column or an average of 60 ft.-0 in. (18m) intervals shall be bonded and connected to the ground system.
3. All conductors shall be secured every 3 ft.-0 in. (900mm) maximum. Fasteners and clips utilized shall be of equal corrosion resistance as the material being secured.
4. Bonding of all conductive material within 6 ft.-0 in. (1800mm) of the conductor shall be accomplished via secondary conductor no smaller than #6 (14mm<sup>2</sup>) copper.
5. Bare copper material shall not be installed on dissimilar metals.
6. Corrosion resistant copper or bronze equipment shall be utilized where these conditions exist. Corrosion resistant copper conductors and fittings shall be utilized where corrosive atmospheres are present.
7. Conductors shall be installed so that a conductor shall always have a horizontal or downward path, free of "U" and "V" pockets, with the exception that an 8 in. (203mm) maximum rise or a rise of 3 in. (80mm) maximum for every 12 in. (300mm) of conductor length shall be permitted in a main conductor run.
8. Each ESE terminal shall have two (2) paths to ground from the base plate of the mast, with the exception of an elevated mast that may have a single conductor run for a maximum of 16 ft.-0 in. (4880mm) before two (2) down conductors shall be initiated.

9. The Electrical Sub-Contractor shall furnish and install all necessary PVC conduit for concealed down conductors.
  10. No bend of a conductor shall be less than ninety (90) degrees and shall not have a radius of bend of less than 8 in. (203mm). Exceptions are through roof and wall assemblies and "T" connections.
- I. Mast
1. Aluminum or galvanized steel mast, height to be determined by the area of protection, with threaded connection for the ESE air terminal and bonding plate for cable connection. Wind and safety factors shall be documented for the geographic area of installation, to determine the size and structure of mast.
  2. Base support, depending upon application, flat mounting base, side mounting base and/or structural support, and/or flag- pole may be utilized.
- J. Grounding System
1. Ground rods shall be copperclad 3/4 in. (20mm) x 10 ft. (3000mm), minimum. One set of tripod grounds shall be installed for each down conductor [two (2) minimum per system; refer to paragraph C, for structural steel used as down conductors, grounding requirements]. Ground plates of high conductivity copper sheet, 20 gauge minimum, 18 in. sq. 460mmsq. three (3) required per down conductor, may be used in lieu of or in combination with ground rods to achieve the ten (10) ohm resistance grounding system requirement. The cable attachments to the ground rods must be accomplished via exothermic welds or mechanical clamp. Cable attachments to the ground plates shall be via cast bronze bond plates of eight 8in2 (5161mm2) of contact area.
  2. A ground loop may be substituted for the ground rods or ground plates. The ground loop must be of a main size conductor and shall comply with the ten (10) Ohm resistance requirement of the grounding system.
  3. Ground rods, ground plates, and ground loop conductors shall be installed a minimum of 1ft. (300mm) below grade and a minimum of 2ft. (600mm) away from the foundation. All grounding locations shall be as evenly spaced around the building perimeter as possible.
  4. A minimum of one inspection well, rated for the traffic of the installation area, shall be installed for each down conductor or two minimum per ground loop.
  5. Bonding of grounded systems shall be via main size conductors. The bonding shall be accomplished to achieve equal potential of all grounds. All underground connections shall be via exothermic welds, where possible.
- K. Connectors, Fittings, Fasteners, and Hardware
1. Provide all connectors, fittings, fasteners, hardware, clamps, guards, lugs, exothermic welds, etc., as required to connect, and install all parts of the system. All equipment shall be fabricated from copper and/or bronze material
- L. Installation-General
1. Installation shall be accomplished in a professional manner by an installer of verifiable ESE system installation.
  2. All work installed within the building shall be concealed.

3. All work installed in accessible locations shall be properly guarded and protected.
4. All material shall be installed in a manner to prevent electrolytic action under presence of moisture.
5. All roof, wall or other building penetrations shall be made in a manner to prevent the ingress of water or moisture. Roof penetrations shall be furnished and installed by the roofing contractor.
6. PVC sleeves shall be provided where conductors pass through all floors; furnished and installed by others.

M. Manufacturer

1. The Lightning Preventor System shall be manufactured by Lightning Preventor of America, Inc., Model No. 2005 or approved equal (Protected Radius, 328 ft.).

2.25 FIRESTOP SYSTEMS

- A. General: Provide firestopping at all new and existing fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 078400 - Firestopping, for all product requirements for maintaining integrity of fire-rated construction at penetrations.

2.26 BI-DIRECTIONAL ANTENNA SYSTEM

A. Summary

1. This specification describes the criteria for deploying an Public Safety Radio Distributed Antenna System (DAS). The DAS components specified in this document include: Bi-Directional Amplifiers (BDA), Donor Antennas, Coverage Antennas, Coax Cable, Coax Connectors, Splitters, Combiners and Couplers. These devices shall be used as part of a system, by the DAS integrator, experienced with designing projects for in-building, public safety, 2-way radio systems.
2. The system specified is based upon TX/RX Systems Bird Technologies Group RescueLine Signal Booster and represents the performance standard upon which any equivalent solution shall be based. It shall be the integrator's responsibility to base the design on the frequency ranges used by both the local Police and Fire departments. The system provided shall meet NFPA 72, 2010, Chapter 24 and Annex A and Massachusetts CMR 780, 403-6, Section 1 codes and shall be designed as such. It shall include a true, integrated battery backup unit which is serially connected to the main BDA system.

B. Abbreviations and Acronyms

1. ACG: Automatic Gain Control
2. AHJ: Authority Having Jurisdiction
3. ATP: Acceptance Test Plan
4. BDA: Bi-Direction Amplifier
5. BOM: Bill-of-Material
6. DAS: Distributed Antenna System

7. EBS: Educational Broadband Service
8. ESMR: Enhanced Specialized Mobile Radio
9. FCC: Federal Communications Commission
10. GUI: Graphical User Interface
11. LMR: Land Mobile Radio
12. MTBF: Mean Time Between Failure
13. NFPA: National Fire Protection Association
14. NMS: Network Management System
15. PSN: Public Safety Network
16. RoF: Radio-over-Fiber
17. RSL: Received Signal Level
18. SMR: Specialized Mobile Radio
19. SMS: Short Message Service
20. SNIR: Signal-to-Noise Interference Ratio
21. SOW: Statement of Work
22. VSWR: Voltage Standing Wave Ratio

C. Definitions

1. Acceptance: Expressed approval by the AHJ and owners representative

D. General Description

1. The building shall be both pre and post tested for fire and police department radio signal strength. A test shall be scheduled with the Fire Department and Police Department. Any expense incurred by the test shall be the responsibility of this trade subcontractor.
2. A site survey to determine the RF signal strength on or near the building grounds to determine the level of amplification necessary to provide clear and reliable radio communications over 95% of the overall area inside the building will be required.
3. The Fire/Police Department radio test shall check the signal reception in several locations on the floor area. Signal strength shall be for clear reception throughout the building utilizing the type of hand held radio unit that is used by the Fire and Police Department. Quantity of test locations shall be determined and conducted by the local department representative. Each floor of the building shall be divided into a grid of approximately twenty (20) equal areas. A maximum of one (1) area will be allowed to fail the test per floor. A spot located approximately in the center of a grid area will be selected for the test. Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted. Field strength testing instruments are to be recently calibrated (1 year) and of the frequency selective type incorporating a flexible antenna similar to the ones used on the hand held transceivers.



4. Required Signal Levels:
  - a. Signal strength shall be for clear reception throughout the building utilizing hand held radio units of the type(s), which are used by the Fire/Police Department. Signal strength testing shall follow TSB-88 standards using delivered audio quality measurements (DAQ).
  - b. A minimum signal strength of  $-95$  dBm (DAQ4) shall be available on over 95% of the floor area required to be covered when transmitted from the fire department.
  - c. A minimum signal strength of  $-95$  dBm (DAQ4) shall be received at the fire department system from over 95% of the floor area required to be covered.
5. Required Broadcasting Frequency:
  - a. Frequency to be compatible with School, Fire and Police Department equipment.
  - b. The building owner will be responsible for keeping the operational frequencies of the BDA compatible with the Fire and Police Department radio system.
6. The bi-directional antenna type system shall consist of the following components:
  - a. Bi-directional radio amplifier
  - b. Plenum rated coaxial cable
  - c. Antennas (internal and external)
  - d. Terminators
  - e. T-taps (if required)
  - f. Other components and interconnecting circuitry
  - g. Battery Backup NFPA Compliant unit (not UPS system)
  - h. Connect power supply to emergency circuit
7. It is the intent of these specifications that where a BDA system is required, a complete fully functioning system shall be installed, approved and tested before an Occupancy Permit is issued.
8. Areas requiring coverage include stairwells corridors, hallways, and other areas designated by the Fire Marshalls and/or the Authority Having Jurisdiction (AHJ).
9. The Electrical Subcontractor shall coordinate with the Fire Marshall's office and Police Department Communications Division to obtain the correct frequencies and other similar information necessary to deploy a complete and fully operational system at this location.
10. Expansion: Without replacing or adding to the Infrastructure, the system shall have expansion capabilities to support the addition or changes of radio frequencies and future building renovations. Any additional Components required for system expansion shall comply with all specifications of this Section.

11. Alarming: The BDA shall include the following outputs which shall interface to the fire alarm system:
  - a. Signal booster malfunction alarm
  - b. Loss of AC Power Alarm
  - c. Low Battery Alarm
  - d. Antenna Circuit Malfunction
  - e. Charge Failure Alarm
  - f. Coordinate the installation of these alarms with the fire alarm contractor.
12. Antenna locations as shown on the drawings are approximations. The system provider is responsible for locating the in-building antennas and the donor antenna required by the equipment selected, proposed design and the design criteria.

E. Design Submissions

1. This trade contractor shall complete a Fire Alarm Permit Application acquired from the Fire Prevention Division stating a "BDA" installation.
2. Plan Review: Provide one line, schematic and detail drawings of the proposed system architecture. Indicate proposed locations for system components. Provide specifications for procurement and installation of a complete system for review by the Fire Department and all other agencies and authorities having jurisdiction (included will be operational frequencies).
3. Testing and Commissioning: Coordinate the completion date of the Fire Department radio signal repeater system so as to permit a Certificate of Occupancy to be obtained in a timely manner, in accordance with a schedule established by the owner's project manager.
4. The entire system shall meet with the approval of the Fire Department and all other agencies and authorities having jurisdiction before a Certificate of Occupancy will be issued.

F. Quality Assurance

1. Qualifications: The Installer shall employ NICET certified technicians.

G. Codes, Standards and Certifications

1. All work, including but not limited to: cabling, pathways, support structures, wiring, equipment, installation, workmanship, maintenance and testing shall comply with the latest editions of the National Fire Protection Association (NFPA), National Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Subcontractor's Association (NECA) Standard of Installation. In case of discrepancy or disagreement between the documents noted above, the Electrical Subcontractor shall satisfy the most stringent requirements.
2. Requirements set forth by first-responder code, ordinance, or the AHJ shall supersede the requirements described herein and shall be met in their entirety. It is The Electrical Subcontractor's responsibility to ensure that the system complies with local code, ordinances or requirements established by the PSN AHJ.

H. Requirements

1. WSP DAS:

- a. On a per channel basis, the downlink RSL for each frequency band shall meet or exceed Design Audio Quality (DAQ) testing criteria.
- b. Prior to installation, contractors shall confirm the channel count, loading and frequencies use in the serving area, and shall guarantee coverage for these channels per DAQ 3.4t criteria. The complete list shall be included as part of The Electrical Subcontractors submittal
- c. The DAS shall deliver coverage throughout 95% of the building, and 100% of areas designated as critical. Coverage areas shall include stairwells, elevators, and underground spaces.
- d. The system shall be housed in a NEMA 4 cabinet and shall include 24 hour battery backup.
- e. The system shall maintain maximum required output power while preventing excessive emissions per FCC requirements.

I. Submittals

1. The Electrical Subcontractor, prior to beginning the on-site installation, is required to submit , for approval by the owner, a complete list of the proposed equipment with a system diagram showing how the various components are interconnected and their function. Included in the submittal shall be:
  - a. Product Data: Submit manufacturer datasheets for the following components:
    - 1) Bi-Directional Amplifiers (BDA)
    - 2) Donor and Coverage Antennas
    - 3) Coaxial Cable and Connectors
    - 4) Splitters, Combiners and Couplers
  - b. Shop Drawings: Submit the following items:
    - 1) RF site survey results
    - 2) System overview and riser diagram.
    - 3) Overlay of system components on floor plans.
    - 4) Donor Antenna lightning suppression and grounding details
  - c. Statement of Work (SOW): Submit a brief description of the DAS integrator role and responsibilities on this project. At a minimum, the services included shall be to perform the RF survey, systems design, test, optimization and commissioning of the DAS system
  - d. Acceptance Test Plan (ATP): Submit a proposed ATP including cable testing reports. At a minimum, testing requirements shall be designed to satisfy requirements of section 3.16.
  - e. Warranty Documents:
    - 1) Submit for all manufactured Components specified in this Section.
    - 2) Submit Contractor's System Warranty.

2. Submittal Requirements at Close Out
  - a. Drawings: Submit as-built drawings indicating:
    - 1) A final, signed copy of all previously submitted documents reflecting the final, as-built representation, equipment used and details
    - 2) Cable routing, splitters, couplers and coverage antenna final locations
    - 3) Active component locations, layout, configuration and programmed parameters
  - b. Test Reports
    - 1) Submit Accepted ATP reports confirming the requirements of Section 1.07 have been met.
  - c. Field Reports: Submit sweep-testing results for all cable runs.
  - d. Field Reports: Submit OTDR test results for all fiber runs.
  - e. Operation and Maintenance Data: Submit hardware and software manuals for all Active Components.
  - f. Warranty Documents:
    - 1) Submit for all manufactured components specified in this Section.
    - 2) Submit Contractor's System Warranty.

J. Warranty

1. Contractor shall warranty that the BDA equipment furnished shall be free from defects of material for a period of 5 years, beginning on the date of substantial completion, excluding specific items of work that require a warranty of a greater period that may be set forth in this Specification. The battery backup unit may carry a standard 1 year warranty. Include any costs necessary to extend the BDA warranty to 5 years.
2. Contractor shall warranty that all other materials furnished shall be free from defects of material for a period of 1 year, from the date of Substantial Completion, excluding specific items of work that require a warranty of a greater period that may be set forth in this Specification. Contractor shall warranty the workmanship for a period of 1 year, from the date of Substantial Completion, excluding specific items of work that require a warranty of a greater period that may be set forth in this Specification. Contractor shall warranty the system's performance for a period of 1 year, from the date of Substantial Completion, excluding specific items of work that require a warranty of a greater period that may be set forth in this Specification. Immediately upon receipt of written notice from the Owner, The Electrical Subcontractor shall repair or replace at no expense to the Owner, any defective material or work that may be discovered before final acceptance of work or within the warranty period; any material or work damaged thereby; and adjacent material or work that may be displaced in repair or replacement. Examination of or failure to examine work by the Owner will not relieve Contractor from these obligations.
3. Manufacturer Warranty:
  - a. Splitters, Couplers and Coverage Antennas: standard manufacturer's warranty
  - b. Coaxial Cable and Connectors: standard manufacturer's warranty

- c. Fiber-Optic Cable: standard.
  - d. Active Components: standard
- K. DAS System Integrators
  - 1. Cybercom
  - 2. Comtronics
  - 3. Applied Communications Services, Inc.
  - 4. Or equal.
- L. Manufacturers
  - 1. Specified BDA Manufacturers:
    - a. TX/RX- Bird Electronics
    - b. CommScope/Andrew
    - c. Cellwave Inc.
    - d. Or equal.
- M. General
  - 1. The system shall be completed with all components and wiring required for compliance with all applicable codes and regulations, and for its operation as described hereinafter. No exclusion from or limitation in the symbolism used on the drawings or the language used in these specifications shall be interpreted as a reason for omitting any appurtenances or accessories required to enable the system to perform the specified functions.
  - 2. Upon completion of the installation, the work shall include making all arrangements with the owner's project manager and providing any assistance necessary for inspection and test required for approval by the Fire Department. Modifications, adjustments and/or corrective work necessary to obtain approval along with subsequent inspection and test resulting from the issuance of a "Notice of Defect" shall precede any consideration of formal acceptance by the building owner. In conjunction with the above, training as deemed necessary to instruct authorized building personnel in the proper operation of the system shall also form a part of the required work. Provide four hours of training.
- N. Power Supply
  - 1. The central equipment shall be supplied with an emergency power unit including batteries and battery charging equipment that maintains this cabinet and all outlying equipment that requires power operation without any change in status for a minimum period of twenty-four (24) hours. The emergency power units(s) shall be sized to meet the following minimum requirements: operating in normal (supervisory) mode, twenty-four (24) hours, followed by twelve (12) hours of emergency operation. Batteries shall be of the sealed maintenance free type.
  - 2. System design shall be such that neither the failure of the normal power source, the transfer to an emergency source, nor the retransfer to the normal source shall cause a change in system status.
  - 3. Serially connected battery backup.

O. Equipment Location and Protection

1. Secured Space: The bi-directional radio amplifiers shall not be located in electric closets. They shall be located in a suitable non-finished space as approved by the engineer and/or where specifically shown on the drawings. The entrance to the secured space shall clearly identify the space as having the "Fire Department" radio signal repeater equipment, by the use of an attached engraved nameplate.
2. Unsecured Space: The bi-directional amplifiers shall be provided with NEMA 4 enclosures, hinged lockable doors, electric supervision against unauthorized access and the removal of any components, and shall each have an attached engraved nameplate identifying the unit.
3. The bi-directional amplifier shall be supplied with cavity style filtering in order to minimize unwanted frequencies from entering the amplifier. Cavities shall be tuned to the frequencies provided by the Fire Department, Police, and School Department. Cavity filters will be housed to allow access by technicians, but will be protected from tampering, or accidental damage.
4. The bi-directional amplifier shall contain automatic limiting control circuitry to avoid producing overdriven outputs from the amplifier.

P. Maintenance

1. Inspection and Test: Provide all material and labor to test system by verifying operation of the system throughout the building. Adjust to provide optimum system performance. Parts and labor for repairs and/or replacements is excluded.

Q. Components

1. Yagi Donor (Outdoor) Antennas:

a. Electrical:

- 1) Frequency band: In accordance with School/Police/Fire Department requirements
- 2) Bandwidth > 1.5 VSWR: 20
- 3) Gain:  $\geq 10$  dB
- 4) Maximum input power: 250 watts
- 5) Vertical Beamwidth: 44 Deg.
- 6) Front-to-back ratio:  $\geq 16$  dB
- 7) Impedance: 50  $\Omega$
- 8) Beamwidth, Horizontal, degrees: 60
- 9) Azimuth Pattern: As proposed by the manufacturer to meet the specifications in this Section.

b. Mechanical:

- 1) Connector: 50  $\Omega$  N Type Female
- 2) Mounting: Pole

c. Environmental:

- 1) Temperature: -40 °C to +60 °C
- 2) Lighting protection: Direct ground
- 3) Waterproof level: IP 66
- 4) Wind Speed, maximum: 125 mph

- 
- 5) Wind Load: 0.45 sq. ft.
  2. Bi-Directional Amplifier (BDA):
    - a. Characteristics
      - 1) Frequency: As determined by Police, Fire Department, and School Department requirements
      - 2) Gain: +80dB maximum
      - 3) Programmable Gain adjustment attenuation, 0-30dB, 0.5 dB steps
      - 4) Maximum Output Power: + 32 dBm
      - 5) Noise Figure: 8 dB maximum
      - 6) Operating Temperature Range: -30 °C to +50 °C
      - 7) Chassis: Shall be capable of rack or wall mounting by the DAS integrators design.
      - 8) Filtering: Digital
      - 9) Separate Control: Each RF amplifier shall be capable of adjusting and controlling power levels for each WSP when multiple WSPs share a single amplifier.
      - 10) FCC Part 90.219 Type Classification: Class A
      - 11) Alarming: Dry contacts for remote alarms
      - 12) Mounting Options: shall support rack, wall and pole mounting
      - 13) Power Consumption: less than 100VA
    - b. Compliance:
      - 1) NFPA: The BDA shall comply with NFPA-1 2009 edition Annex O In-Building Public Safety Radio Enhancement Systems.
      - 2) FCC: Shall be FCC type certified.
  3. Air Dielectric, Plenum Rated Cable:
    - a. Material Characteristics:
      - 1) Jacket: Halogenated, Fire-Retardant, Plenum rated
      - 2) Outer Conductor Material: Corrugated Aluminum or Corrugated Copper
      - 3) Inner Conductor Material: Copper-Clad Aluminum Wire
    - b. Electrical Characteristics:
      - 1) Impedance:  $50 \pm 2.0 \Omega$
      - 2) Frequency Band: 1 – 8800 MHz
      - 3) Peak Power Rating:  $\geq 40.0 \text{ kW}$
    - c. Mechanical Characteristics:
      - 1) Diameter Over Jacket:  $\leq .627 \text{ in}$
      - 2) Minimum Bending Radius:  $\leq 5 \text{ in}$
      - 3) One Time Minimum Bending Radius:  $\leq 3 \text{ in}$
      - 4) Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)
  4. Foam Dielectric Cable: To be used for donor antenna and outdoors.
    - a. Material Characteristics:
      - 1) Jacket: Non-halogenated, Fire-Retardant Polyolefin
      - 2) Outer Conductor Material: Corrugated Copper

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- 3) Inner Conductor Material: Copper-Clad Aluminum Wire or Copper Tube
  - b. Electrical Characteristics:
    - 1) Impedance:  $50 \pm 1.0 \Omega$
    - 2) Frequency Band:  $\frac{1}{2}$ " Nominal: 1 – 8800 MHz,  $\frac{7}{8}$ " Nominal: 1 – 5000 MHz
    - 3) Peak Power Rating:  $\geq 40.0 \text{ kW}$
  - c. Mechanical Characteristics:
    - 1) Diameter Over Jacket:  $\frac{1}{2}$ " Nominal:  $\leq .630 \text{ in}$ ,  $\frac{7}{8}$ " Nominal:  $\leq 1.1 \text{ in}$
    - 2) Minimum Bending Radius:  $\frac{1}{2}$ " Nominal:  $\leq 5 \text{ in}$ ,  $\frac{7}{8}$ " Nominal:  $\leq 10 \text{ in}$
    - 3) One Time Minimum Bending Radius:  $\frac{1}{2}$ " Nominal:  $\leq 2 \text{ in}$ ,  $\frac{7}{8}$ " Nominal:  $\leq 5 \text{ in}$
  - d. Attenuation Characteristics:  $\frac{1}{2}$ " Nominal
    - 1) Frequency (MHz) Attenuation (dB/100ft):  $450 \leq 1.447$
    - 2) Standard Conditions: VSWR 1.0, ambient temperature  $20 \text{ }^\circ\text{C}$  ( $68 \text{ }^\circ\text{F}$ )
  - e. Attenuation Characteristics:  $\frac{7}{8}$ " Nominal:
    - 1) Frequency (MHz) Attenuation (dB/100ft):  $450 \leq .744$
    - 2) Standard Conditions: VSWR 1.0, ambient temperature  $20 \text{ }^\circ\text{C}$  ( $68 \text{ }^\circ\text{F}$ )
5. Fiber-Optic Master Unit: Active fiber system, the Fiber- Optic Master Unit shall convert radio over coax to Radio-Over-Fiber (RoF) for distribution to Fiber-Optic Remote Units.
- a. Characteristics
    - 1) Transmission Media: Single-mode fiber at 1310 nm
    - 2) Operating Temperature Range:  $+5 \text{ }^\circ\text{C}$  to  $+40 \text{ }^\circ\text{C}$
    - 3) Impedance:  $50 \Omega$
    - 4) Chassis:
      - a) Shall be of modular design capable of supporting  $\geq 32$  Remote Units per 19", 4 RU chassis
      - b) Shall support redundant power supplies
      - c) Shall have the capability to remotely power the Remote Units via composite fiber-optic cable
  - b. Automatic Gain Control (AGC): Shall provide AGC for optical loss compensation
  - c. Optical Budget: Shall support  $\leq 3 \text{ dB}$  optical budget ( $\sim 3 \text{ km}$  or 2 miles)
  - d. Auxiliary Channel: Shall provide an input to support 400 to 2700 MHz for future
  - e. expandability
  - f. Interlink: Shall support one fiber or two fibers bi-directional optical link for distances up to 20 km with a 10 dB optical budget



- g. Remote Supervision:
  - 1) Shall support the TCP/IP protocol, SNMPv2, FTP, HTTP, Telnet, and be fully compatible with general purpose SNMP managers
  - 2) Remote access shall be available via Point-to-Point Protocol (PPP), over circuitswitched/ packet data and wired/wireless modems
  - 3) Each Active device shall be manageable via a Web GUI
  - 4) Auto Mapping: Each board position shall be automatically mapped during system turn-up
- h. Frequency Bands Supported: 800 MHz PSR. There are (3) frequencies used (two police and one fire).

R. Installation

- 1. The Electrical Subcontractor shall install the DAS in accordance with the integrator's instructions and recommendations.
- 2. Cable and Equipment:
  - a. Installation shall include the delivery, unloading, setting in place, fastening to walls, floors, ceiling, or other structures and where required, penetration fire-stop, interconnecting wiring of the system components, equipment alignment and adjustments, and all other work whether or not expressly required herein which is necessary to result in complete operational system.
  - b. All installation practices shall be in accordance with, but not limited to, these specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements and recommendations of National, State, and Local Authorities having jurisdiction. All distributed antenna cables shall be installed such that the cables are straight as possible.
  - c. During the installation, and up to the date of final acceptance, the integrator shall be under obligation to protect his finished and unfinished work against damage and loss. In the event of such damage or loss, he shall replace or repair such work at no cost to the owner.
  - d. All equipment shall be properly mounted on equipment racks or walls and secured in place. Wall mounted equipment shall be mounted over a ½" plywood securely attached to the wall.
  - e. Cables shall be properly supported with dedicated hangers or brackets. Cable trays shall be used only if they are dedicated low voltage trays and only with approval from the owner.
  - f. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three.
  - g. All boxes, equipment, etc shall be secured plumb, level and square.
  - h. In the installation of equipment and cable, consideration shall be given to operational efficiency and overall aesthetic factors. Antennas shall be centered and in-line with other ceiling mounted devices

- i. All cables, regardless of length, shall be marked with cable markers reading "Public Safety Radio", at regular intervals but not less than every 30 ft. There shall be no unmarked cables at any place in the system. In addition, markings codes at each end of the cables and patch panels shall correspond to codes shown on drawings and/or run sheets.
- j. All cables the integrator installs must be handled in accordance with the manufacturers guidelines. Transmission line cables have minimum bending radius specifications that shall be followed. In the event a cable is kinked or bent excessively during installation that section of cable cannot be used, even if subsequently straightened. The damaged area of the cable shall be removed and a new section installed using correct splice methods. Ultimately the cable must pass the testing and meet the manufacturer's requirements
- k. Radio communications cabling shall not be grouped with electrical cabling. It can only share sleeves and raceways with other low voltage data and communications cables.
- l. Connection between cables and other antenna components shall use N-Type premium connectors. No splicing is permitted.
- m. All power dividers shall be securely mounted in place by bolting the mount to a solid surface or securing each by suspension on the cables within 4 inches of each connector termination at the power divider. The transmission lines connecting to the device shall be routed in the shortest possible path.

S. Grounding Procedure

- 1. In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, the following grounding procedures shall be adhered to:
- 2. System Ground: A signal primary "system ground" shall be established for the system. All grounding conductors in that area shall connect to this primary system ground. The system ground shall consist of a copper bar of sufficient size to accommodate all secondary ground conductors. An extension of the ground shall connect to the buildings lightning protection system per the direction of the on-site electrical engineer.
- 3. A copper conductor, having a maximum of 0.1 Ohms total resistance, shall connect the primary system ground bar to the primary system ground ring.
- 4. Secondary system grounding conductors shall be provided from all racks, radio consoles, and undergrounded radio equipment in each area, to the primary system grounding point for the area. Each of these grounding conductors shall have a maximum of 0.1 Ohms total resistance.
- 5. Under no conditions shall the AC neutral conductor, either in the power panel or in receptacle outlets, be used for a BDA system ground.
- 6. Radio cable Shields: All radio cable shields shall be grounded at both ends.
- 7. General: Because of the great number of possible variations in grounding systems, it shall be the responsibility of the installer to follow good engineering practice, as outlined above, and to deviate from these practices only when necessary to minimize crosstalk and to maximize signal to- noise ratios and reduce interference in the radio systems.

T. Cable and Conduit

1. Note the following circuitry requirements:
  - a. Conduit intended for use with the firefighter's communication bi-directional radio amplifier system shall be steel electric metallic tubing (EMT), except as follows:
    - 1) It shall be galvanized steel intermediate conduit where mounted within 8'-0" of the floor in mechanical spaces or otherwise exposed to mechanical damage, or where intended for embedment in concrete.
    - 2) It shall be galvanized steel intermediate conduit if local authorities prohibit use of EMT.
    - 3) It shall be rigid galvanized steel conduit for the power supply to the central equipment and to all outlying equipment cabinets requiring a 120-volt or 120/208- volt supply.
  - b. Where wires and cables are permitted to be run without conduit, they shall be independently supported from the building structure or ceiling suspension systems at intervals not exceeding four feet on center, utilizing cable supports specifically approved for the purpose. Wires and cables shall not rest on or depend on support from suspended ceiling media (tiles, lath, plaster, as well as splines, runners or bars in the plane of the ceiling), nor shall they be supported from pipes, ducts or conduits. Bundling and/or supporting ties shall be of a type suitable for use in a ceiling air handling plenum regardless of whether or not installed in a plenum.
  - c. Cables shall be tagged or labeled at each termination point and in each intermediate junction box, pull box or cabinet through which they pass, as well as intervals not exceeding 50 feet on centers where cables are run without conduit.
  - d. Comply with applicable building and electrical code requirements for locating and routing circuitry, for installing circuitry, and for fire stopping.
  - e. The covers of all dedicated junction, pull boxes shall be painted red and labeled "Fire Dept. Radio System". Junction and pull boxes will not be shared with other systems.
  - f. Cables other than radiating coaxial cables shall be run in conduit where indicated by the Engineer. Where not indicated, cable shall be installed per manufacturer's recommendation. Conduit shall be electric metallic or threaded conduit subject to the restrictions specified elsewhere for light and power circuitry.
  - g. Radiating coaxial cables shall be run without conduit. Where installed in a plenum type ceiling cable insulation shall be of a fire-resistant low-smoke producing type, with a minimum rating of CATVR. This classification shall be clearly marked on the outer surface of the cable at regular intervals.

U. Acceptance Testing

1. Submit certification that system is compatible with Police and Fire Department radio systems prior to installation. There are (3) frequencies required.
2. Verify proper operation of system by means of field test with:

3. Fire Department requirements, and include all adjustments and modifications to the system required for proper operation. Coverage of each floor of the building to a minimum of 95% is required for acceptance.
4. No activation, or power up of any RF equipment is permitted without first obtaining permission of the Fire Department. This includes any testing or calibration.
5. The Electrical Subcontractor shall complete the acceptance testing as prescribed in the approved Acceptance Test Plan (ATP) submittal.
6. Acceptance Test Procedure: Upon completion of installation, the building Owner will have the option to participate in the radio system tested to ensure that two-way radio coverage on each floor of the building is a minimum of 90 percent. And be tested as follows:
7. Each floor of the building shall be divided into a grid of 20 or more, approximately equal areas. No two test locations shall be greater than 50 ft apart
8. The test shall be conducted using a calibrated portable radio of the latest brand and model used by the agency talking through the agency's radio communications system.
9. No area designated as critical and no two adjacent areas shall be allowed to fail the test.
10. In the event that any three non-adjacent, non-critical areas fail the test, in order to be more statistically accurate, the floor may be divided into smaller areas. In the event that three noncritical, non-adjacent areas still fail the test, the Electrical Subcontractor shall reconfigure the system to meet the 90-percent coverage requirement with no three adjacent areas failing.
11. A test location approximately in the center of each grid area shall be selected for the test by the public safety or owner's representative, then the radio shall be enabled to verify two-way communications to and from the outside of the building through the public agency's radio communications system. Once the test location has been selected, that location shall represent the entire area. If the test fails in the selected test location, that grid area shall fail, and prospecting for a better spot within the grid area shall not be allowed.
12. The gain values of all amplifiers shall be measured and the test measurement results shall be noted on the as-built drawings and the O&M manuals so that the measurements can be verified during annual tests.
13. As part of the installation a spectrum analyzer or other suitable test equipment shall be utilized to insure spurious oscillations are not being generated by the subject signal booster. This test shall be conducted at time of system acceptance.

#### 2.27 LEVEL 2 AC DUAL ELECTRIC VEHICLE CHARGING EQUIPMENT (EVSE)

- A. Scope: Furnish and install Level 2 AC Dual Electric Vehicle Charging equipment as specified herein and as shown on the contract drawings.

- B. References: The electric vehicle supply equipment (EVSE) and all components shall be designed, manufactured and tested in accordance with the latest version of the following standards (unless otherwise noted):
1. SAE J1772, Electric Vehicle Conductive Charge Coupler
  2. SAE J2836 , Use Cases for Communication Between Plug-in Vehicles and the Utility Grid
  3. SAE J2847, Communication between Plug-in Vehicles and the Utility Grid
  4. SAE J2931, Digital Communications for Plug-in Electric Vehicles
  5. National Electric Code Article 625, Electric Vehicle Charging System
  6. UL 2231, Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits
  7. UL 2594, Electric Vehicle Supply Equipment
  8. UL 1998, Software in Programmable Components
  9. CSA C22.2 No. 107.1, General Use Power Supplies
  10. FCC Part 15, Class B
- C. Submittals – for Review/Approval
1. The following information shall be submitted to the Engineer:
    - a. Product data sheets
    - b. Installation Manuals
- D. Submittals – for construction
1. The following information shall be submitted for record purposes:
    - a. Final as-built drawings
    - b. Wiring diagrams
    - c. Installation information including equipment anchorage provisions
- E. Qualifications
1. The manufacturer shall have been self-manufacturing EVSE or similar transportation electrification equipment for a minimum of three years. The manufacturer shall also have been in manufacturing for a minimum of five (5) years.
- F. Delivery, Storage and Handling
1. EVSE being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition as required by the manufacturer's instructions, in accordance with manufacturer's instructions (1) copy of these instructions shall be included with the equipment at time of shipment.
- G. Operation and Maintenance Manuals
1. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly.

- H. Warranty
  - 1. The manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of substantial completion.
  
- I. Manufacturers
  - 1. Chargepoint
  - 2. Siemens
  - 3. General Electric
  - 4. Or equal
  - 5. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  
- J. Construction
  - 1. Provide a third party recognized AC, Level 2 charging station, quantities and current ratings as shown on drawings.
  - 2. Physical Specifications
    - a. Enclosure Construction and Finish
      - 1) Enclosure shall be manufactured from aluminum or other corrosion resistant material
      - 2) Enclosure shall consist of a coat of thermosetting, polyester powder paint applied electrostatically with a metallic finish.
    - b. Enclosure Mounting
      - 1) Pedestal Mount Single SAE J1772 connector
    - c. Cable Length
      - 1) 25 feet
    - d. Connector and Cable Management
      - 1) The EVSE shall incorporate a cord management system or method to minimize the potential for cable entanglement, user injury or connector damage from lying on the ground and comply with NEC articles 625 as it applies to cord management systems.
      - 2) The EVSE shall include a dock for inserting the SAE J1772 connector when not in use.
      - 3) The EVSE connector and cable assembly shall be field replaceable.
    - e. The EVSE shall include a removable device panel to allow for field retrofits and replacement of optional equipment.
  - 3. Environmental
    - a. Operating Temperature
      - 1) -22 deg. F (-30 deg. C) to 104 deg. F (40 deg. C)
    - b. Surge Withstand
      - 1) 6kV at 3000A
    - c. Humidity
      - 1) 90% relative humidity, non-condensing

- 2) Corrosion Resistance
  - 3) The enclosure coating shall have a corrosion resistance of 600 hours to 5% salt spray.
  - d. The printed circuit boards (PCB's) integral to the EVSE shall be conformal coated.
  4. User Interface
    - a. The station's display shall be simple, with universal symbols accompanying text to allow easy understanding and use of the EVSE.
    - b. The EVSE shall include the following status indicators:
      - 1) Power
      - 2) Charging
      - 3) Charging Complete
      - 4) Remotely Controlled
      - 5) Temporary Fault
      - 6) Service
    - c. The EVSE shall include the following:
      - 1) Reset Pushbutton
  5. Protection
    - a. The EVSE shall provide integral overcurrent protection at 5% over the nameplate rating.
    - b. The EVSE shall provide integral ground fault interruption of 20mA per UL 2231.
    - c. The EVSE shall incorporate an automatic ground fault detection feature at the beginning of each plug session.
    - d. The EVSE shall incorporate a manual ground fault test feature.
      - 1) The EVSE shall include a DIP switch enabled Automatic Reset feature to allow the station to reset after a temporary fault without user interaction.
    - e. The EVSE shall include a DIP switch enabled Soft Start feature to allow for the ramp up of current to the Available Line Current or Nameplate Current Rating of EVSE.
    - f. The EVSE shall include a Cold-Load Pickup feature to allow for randomized restart on power failure and/or delay before charging resumes after a power failure.
  6. Input / Output
    - a. The EVSE shall include a normally closed (NC) dry contact permissive run input.
  7. Communications and Data Collection
    - a. The EVSE shall be open architecture with native Modbus RTU and RS-232 Serial communications.
    - b. The EVSE shall allow for curtailment of the maximum current output through Modbus communications.
    - c. The EVSE shall be capable of Master / End Device configurations through a Modbus RTU daisy chain topology.
  8. Required Accessories
-

- a. Systems Integration Enabled
  - 1) Communications for Open Charge Point Protocol networking
  - 2) Authentication and Payment Authorization
    - a) Swipe Credit Card Reader for time based payments
  
- K. Factory Testing
  - 1. Each EVSE shall undergo factory testing of all operational and protective features prior to shipment.
  
- L. Installation
  - 1. The Contractor shall install all equipment per the manufacturer's recommendations and contract drawings.
  - 2. All necessary hardware to secure the assembly in place shall be provided by the Contractor.
  
- M. Training
  - 1. Provide four (4) hours of owner training with manufacturer's representative present.

### **PART 3 -EXECUTION**

#### **3.1 INSPECTION AND ACCEPTANCE**

- A. Examine all surfaces and contiguous elements to receive work of this section and correct, as part of the Work of this Contract, any defects affecting installation. Commencement of work will be construed as complete acceptability of surfaces and contiguous elements.

#### **3.2 WORK COORDINATION AND JOB OPERATIONS**

- A. Equipment shall not be installed in congested and possible problem areas without first coordinating installation of same with other trades. Relocate electrical equipment installed in congested or problem areas should it interfere with the proper installation of equipment to be installed by other trades.
  
- B. Particular attention shall be directed to coordination of lighting fixtures and other electrically operated equipment requiring access which is to be installed in ceiling areas. Coordinate with other trades, the elevations of equipment in hung ceiling areas to insure adequate space for installation of recessed fixtures before said equipment is installed. Conflicts in mounting heights and clearances above hung ceilings for installation of recessed lighting fixtures or other electrically operated equipment requiring access shall be brought to the attention of Architect for a decision prior to equipment installation.
  
- C. Furnish to General Contractor and other subcontractors information relative to portions of electrical installation that will affect other trades sufficiently in advance so that they may plan their work and installation.
  
- D. Obtain from other trades information relative to electrical work which he, the Electrical Subcontractor, is to execute in conjunction with installation of other trades' equipment.



- E. Lighting fixtures in mechanical spaces or utility/ storage rooms shall only be installed after all mechanical equipment is in place.

### 3.3 PLANS AND SPECIFICATIONS

#### A. Plans:

- 1. Drawings showing layout of electrical systems indicate approximate location of raceways, outlets, and apparatus. Runs of feeders and branch circuits are schematic and are not intended to show exact routing. Final determination as to routing shall be governed by structural conditions and as indicated on the approved coordination drawings.

#### B. Specifications:

- 1. Specifications supplement drawings and provide specifics pertaining to methods and material to be used.

### 3.4 IDENTIFICATION

#### A. Equipment shall be marked for ease of identification as follows:

- 1. Provide screw-on nameplates on switchboards, panelboards, F.A. terminal cabinets, starters, and disconnect switches. Nameplates to be of black phenolic with white engraving. For starters and disconnect switches lettering shall be minimum of 1/4 in. high. Nameplates on panelboards shall have the following information.
  - a. Line 1 - Panel designation in 1/2 in. high letters.
  - b. Line 2 - Utilization voltage in 3/8 in. high letters.
  - c. Line 3 - Distribution source "Fed from 1/4 in. high letters.
- 2. Neatly typed directory cards listing circuit designations shall be fastened inside the cover of panelboards. Spare circuits shall be penciled.
- 3. Color coding schedules. If there is more than a single system voltage, different voltages shall have separate color codes, as previously specified. A copy of the color code schedule shall be affixed to each secondary switchboard and distribution panel and shall be of the phenolic nameplate type as previously specified. A typewritten color code schedule shall also be affixed, under plastic, inside each panelboard door.
- 4. Outlet boxes both concealed and exposed shall be identified as to panel origination and circuit number by means of fibre pen on the inside of coverplate.
- 5. Special system outlet boxes concealed above hung ceilings shall be identified as to system by spray painting during roughing. The following systems shall be identified.
  - a. Fire Alarm - red.
  - b. Normal/Emergency - yellow.
  - c. Security - blue.
  - d. Sound - green.
- 6. Wiring device plates on devices connected to normal-emergency circuits shall be red in color.

7. All conductors in boxes larger than standard outlet boxes, in all wireways, and trench headers. shall be grouped logically and be identified.
8. Grounding conductors and neutrals shall be labeled in panels, and wireways. as to circuits associated with.
9. All devices including receptacles and switch covers shall be labeled with circuit and panel designation. Label shall be phenolic with white engraving. Provide sample for approval.
10. Equipment nameplates shall include date of manufacturer.
11. Distribution Equipment: Identify major components of the distribution system (such as circuit breakers, switches, transformers, switchboards, panelboards, motor control centers) with nameplates. Nameplates on disconnect switches and control stations shall identify the equipment served.

### 3.5 PROTECTION AND CLEANUP

#### A. Protection:

1. Materials and equipment shall be suitably stored and protected from weather.
2. During progress of work, pipe and equipment openings shall be temporarily closed so as to prevent obstruction and damage.
3. Be responsible for maintenance and protection of material and equipment until final acceptance.

#### B. Cleanup:

1. Keep job site free from accumulation of waste material and rubbish. Remove all rubbish, construction equipment, and surplus materials from site and leave premises in a clean condition.
2. At completion, equipment with factory finished surfaces shall be cleaned and damaged spots touched up with the same type paint applied at factory.
3. Particular attention is called to Section 110-12(c) of the NEC, which requires that internal parts of electrical equipment not be contaminated by construction operations.

### 3.6 PORTABLE OR DETACHABLE PARTS

- #### A.
- Retain possession of and be responsible for spare parts, portable and detachable parts, and other removable portions of installation including fuses, keys, locks, blocking clips, inserts, lamps, instructions, drawings, and other devices or materials that are relative to and necessary for proper operation and maintenance of the system until final acceptance, at which time such parts shall be installed or turned over to the Owner, as the case may be.

#### B. SAFETY PRECAUTIONS

1. Provide proper guards, signage, and other necessary construction required for prevention of accidents and to insure safety of life and property. Remove any temporary safety precautions at completion.

### 3.7 MOUNTING HEIGHTS

- A. All electrical equipment shall be mounted at the following heights unless noted or detailed otherwise on drawings. Notes on architectural drawings shall supersede those noted below or detailed on the electrical drawings. If mounting height of an electrical component is questionable, obtain clarification from Architect before installation.
1. Duplex convenience outlets, microphone outlets, and telephone outlets - 18 inches.
  2. Light switches, pushbutton stations, HOA switches, and all other toggle or control switches for the operation of heating, ventilating, and air conditioning, plumbing, and general service - 48 inches.
  3. Clock outlets - 84 inches.
  4. Fire alarm pull stations - 48 inches.
  5. Fire alarm audio visual signals - 80 inches or 6 inches below ceiling, whichever is lower.
  6. Panelboards for lighting, power, telephone, and other auxiliary systems – 78 in. to top.
  7. Equipment located in lobbies shall be located as detailed on architectural drawings.
  8. All receptacles, light switches, fire alarm signals, and clocks sharing a common location shall be symmetrically arranged.
  9. Exterior and interior wall brackets shall be as detailed on architectural drawings.
- B. Mounting heights given are from finished floor to centerline. In the case of a raised floor, surface of raised floor is the finished floor.

### 3.8 WORKMANSHIP AND INSTALLATION METHODS

- A. Work shall be installed in first-class manner consistent with best current trade practices. Equipment shall be securely installed plumb and/or level. Flush-mounted outlet boxes shall have front edge flush with finished wall surface. No electrical equipment shall be supported by work of other trades. Cable systems shall be supported and not draped over ducts and piping or laid on ceiling suspension members. Lighting fixtures shall be installed to agree with Architects reflected ceiling plans and the requirement of 230548 Vibration Control and Seismic Restraints.
- B. Supports:
1. Support work in accordance with best industry practice and by use of standard fittings.
  2. In general, walls and partitions will not be suitable for supporting weight of panelboards, dry type transformers and the like. Provide supporting frames or racks extending from floor slab to structure above.
  3. Provide supporting frames or racks for equipment, intended for vertical surface mounting in free standing position where no walls exist.

4. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of equipment.
5. Provide 3/4 in. thick painted plywood mounting surfaces in all electric and telephone areas and for all equipment on free standing racks. All plywood shall be fire retardant and painted both sides and edges with 2 coats of white paint.
6. No work for exposed installations in damp locations shall be mounted directly on any building surface. In such locations, flat bar members or spacers shall be used to create a minimum of 1/4 in. air space between building surfaces and work.
7. Nothing (including outlet, pull and junction boxes and fittings) shall depend on electric raceways or cables for support. All outlet, pull, and junction boxes shall be independently supported.
8. Nothing shall rest on, or depend for support on, suspended ceiling or its mounting members.
9. Support surface or pendant mounted lighting fixtures:
  - a. From outlet box by means of an interposed metal strap, where weight is less than five pounds.
  - b. From outlet box by means of a hickey or other direct threaded connection, where weight is from five to fifty pounds.
  - c. Directly from structural slab, deck or framing member, where weight exceeds fifty pounds.
  - d. Pendant lighting fixtures shall be supported by threaded rods in non-public areas and by manufacturers standard tube hangers with swivel aligner and canopy in public areas. Provide non-standard pendant lengths where required to mount fixtures at elevations either called for on drawings or as shown in architectural elevations.
10. Support recessed lighting fixtures directly from structural slabs, decks or framing members, by means of jack chain or air craft cable, one at each end of fixture at opposite corners.
11. Where support members must of necessity penetrate air ducts, provide airtight sealing provisions which allow for a relative movement between the support members and the duct walls.
12. Provide channel sills or skids for leveling and support of all floor mounted electrical equipment.
13. Where permitted loading is exceeded by direct application of electrical equipment to a slab or deck, provide proper dunnage to distribute the weight in a safe manner.
14. Support metallic raceways by either running within steel frame or hung from the building frame. Anything hung from building frame shall be attached with metallic fasteners.
15. electrical subcontractor to provide "in process" panel schedule sheet while loads are being connected. Electrical subcontractor to review phase loading at panelboards at the end of work and prior to closeout to ensure balanced loading. Provide a final typed panel schedule at completion of work.

C. Fastenings:

1. Fasten electric work to building structure in accordance with the best industry practice.
2. Where weight applied to attachment points is 100 pounds or less, fasten to building elements of:
  - a. Wood -- with wood screws.
  - b. Concrete and solid masonry -- with bolts and expansion shields.
  - c. Hollow construction -- with toggle bolts.
  - d. Solid metal -- with machine screws in tapped holes or with welded studs.
3. Where weight applied to attachment points exceeds 100 pounds, fasten as follows:
  - a. At field poured concrete slabs, provide inserts with 18 in. minimum length slip-through steel rods, set transverse to reinforcing steel.
  - b. Where building is steel framed, utilize suitable auxiliary channel or angle iron bridging between structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
4. Floor mounted equipment shall not be held in place solely by its own dead weight. Provide floor anchor fastenings. Floor mounted equipment over 72 inches in height shall also be braced to nearest wall or overhead structural elements.
5. For items which are shown as being mounted at locations where fastenings to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging to building structural elements.
6. Fastenings for metallic raceways using the fastening as support shall be of the metallic type. Fastenings to hold raceways or cables in place may be via traps.
7. Refer to section 230548 Vibration Control and Seismic Restraints for additional requirements.

D. General Raceway Installation:

1. Install the various types of raceways in permitted locations as previously specified. All raceways shall be run concealed. Consult Architect for instruction for raceways which must be exposed in public spaces.
2. Raceways for normal emergency or emergency only wiring cannot contain other conductors.
3. Raceways shall be properly aligned, grouped, and supported in accordance with code. Exposed raceways shall be installed at right angles to or parallel with structural members. Concealed raceways may take most direct route between outlets.
4. Raceways run on trapeze hangers shall be secured to the trapeze.
5. Raceways shall be continuous and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous from service to all outlets. Provide grounding bushings and bonding jumpers where raceways attach to painted enclosures or terminate below equipment.

6. Where raceways enter boxes, cabinets, tap boxes, other than those having threaded hubs, a standard locknut shall be used on the outside and locknut and bushing on the inside.
7. Where raceways terminate below equipment and there is no direct metal to metal continuity, provide grounding bushings on raceways and interconnect with equipment grounding conductor.
8. All empty raceways shall be provided with a pull wire.
9. All raceway sleeves, stub-ups, or stub-outs, where not connected to a box or cabinet, shall be terminated with a bushing.
10. All raceway joints shall be made up tight and no running threads will be permitted.
11. Where raceways are cut, the inside edge shall be reamed smooth to prevent injury to conductors.
12. All vertical raceways passing through floor slabs shall be supported.
13. Raceways shall not be installed in concrete slabs above grade or below waterproofed slabs.
14. Electric raceways and/or sleeves passing through floors or walls shall be of such size and in such location as not to impair strength of construction. Where raceways alter structural strength or the installation is questionable, the structural engineer shall be contacted for approval.
15. Raceways shall not run directly above or below heat producing apparatus such as boilers, nor shall raceways run parallel within 6 inches of heated pipes. Raceways crossing heated pipes shall maintain at least a 1 inch space from them.
16. Raceways shall be installed in such a manner as to prevent collection of trapped condensates, and all runs shall be arranged to drain.
17. Raceways passing between refrigerated and non-refrigerated spaces and those penetrating enclosures with air movement shall be provided with seals.
18. Raceways feeding fire and jockey pumps shall be rigid metal conduit either run below slab or inside 2 hour rated enclosure. Final connections to motors shall be liquidtight flexible conduit.
19. Where two alternate wiring methods interconnect such as EMT to flexible metal conduit, an outlet box shall be provided.
20. All empty raceways entering building and all sleeves or core drilled openings through floors shall be sealed.
21. Each exterior raceway or assembly in a ductbank shall be provided with continuous warning tape installed 12 inches above raceway or ductbank.
22. Underground rigid non-metallic raceways where allowed and run as a ductbank encased in concrete shall be installed with plastic spacers to ensure a separation of 3 inches between raceways. Top of ductbanks shall be 30 inches below grade, unless otherwise detailed.
23. Elbows and extensions of rigid non-metallic raceway systems which penetrate slabs shall be rigid or intermediate metal conduit.
24. Raceways used for transformer connections shall be flexible type and shall contain a grounding conductor.

25. Raceways entering building through foundation wall into a basement area shall be provided with wall entrance seals or with other acceptable waterproofing method.

E. General Outlet Box Installation:

1. Boxes shall be set flush with finish surface and provided with proper type extension rings or plaster covers. Thru the wall boxes are not permitted. Check device or fixture to be mounted to box to ensure box orientation is proper.
2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operation.
3. Plug unused openings on all remove knockouts.
4. Where required for horizontal and vertical alignment of boxes in stud partitions, bar hangers spanning two studs shall be used. Device boxes for insertion type receptacles shall be provided with far side box supports where there are less than two entering nonflexible raceways, and where bar rangers are not provided.
5. Boxes flush mounted in fire rated partitions and on opposite sides of the partition shall be separated by a distance of 24 inches in accordance with UL listing for the box.
6. Locations of outlets indicated on drawings are approximate. For items exposed to view, refer to architectural drawings and coordinate locations with masonry joints, panel joints, ceiling grids, and structural members.
7. In case of conflict with standard mounting heights and device alignment, consult Architect prior to roughing.
8. Check all door swings on architectural drawings to ensure lighting switches are installed on strike side of door.
9. The right to make any reasonable change in location of outlets prior to roughing is reserved by Architect. "Reasonable change" shall be interpreted as movement within 10 feet of location shown.
10. Obtain dimensioned plan from Architect for floor outlets.
11. Outlet boxes for use where surface metal raceways are allowed shall be of a type specifically designed to be used with such surface metal raceway systems.

F. Conductor Installation:

1. No conductors shall be pulled into individual raceways until such raceway system is complete and free of debris. No harmful lubricants shall be used to ease pulling.
2. All conductors shall be wired so that grounded conductor is unbroken; switches in all cases being connected in ungrounded conductor.
3. Connections throughout the entire job shall be made with solderless type devices of approved design satisfactory to Inspector of Wires.
4. All taps and splices shall be insulated equal to that of conductor insulation.
5. All conductors of each feeder in pull boxes and wireways shall be grouped, tied together, supported, and identified.

6. All conductors in panelboards and other wiring enclosures shall be neatly formed and grouped.
  7. All conductors of emergency only and/or normal/emergency shall be run in separate raceway systems to final outlet box.
  8. Provide support for conductors in vertical raceways in accordance with Article 300-19.
  9. Strip insulation from conductors with approved tools and only of sufficient length for proper termination. Cutting of conductor stranding is unacceptable.
  10. Taps from paralleled conductors shall be of a type which tap each conductor, such as ILSCO "PTA" series.
  11. Grounding conductors are to be identified as to associated power circuits.
- G. Type MC Cable Installation:
1. Where cable is permitted under the products section, the installation of same shall be done in accordance with code and the following:
    - a. Cable shall be supported in accordance with code. Tie wire is not an acceptable means of support. Horizontally run cable supports such as Caddy WMX-6, and clamps on vertical runs such as Caddy CJ6 shall be used. Where cables are supported by the structure and only need securing in place, then ty-raps will also be acceptable. Ty-raps are not acceptable as a means of support. All fittings, hangers, and clamps for support and termination of cables shall be of types specifically designed for use with cable, i.e., romex connectors not acceptable.
    - b. Armor of cable shall be removed with rotary cutter device equal to roto-split by Seatek Co., not with hacksaw.
    - c. Use split "insuliner" sleeves at terminations.
    - d. Any cable system used in conjunction with isolated ground circuits shall have both an isolated ground conductor and an equipment ground conductor.
- H. Stranded Conductor Installation:
1. If Contractor selects stranded conductors for #10 AWG and smaller, terminate such conductors as follows:
    - a. No stranded conductor may be terminated under a screwhead. Provide insulated terminal lugs for all screw connections equal to Thomas & Betts "STA-KON" type RC with forked tongue and turned up toes. Installation of lugs shall be done with compression tool such as T&B WT-145C which prevents opening of tool until full compression action is completed.
    - b. Backwired wiring devices shall be of clamp type; screw tightened. Force fit connections not allowed.
  2. Stranded conductors will not be allowed for fire alarm work.
- I. Accessibility:
1. Electrical equipment requiring service or manual operation shall be accessible.



2. Work switches for equipment within accessible hung ceiling spaces, such as fan powered terminal boxes, shall be located at terminal box, and so located so as to be accessible.

- J. Vibration Elimination: All equipment connections to rotating equipment or equipment capable of vibration shall be made up by flexible raceways.
- K. Wiring Device Gaskets: Provide wiring device gaskets at coverplates where device is mounted in wall separating conditioned and non-conditioned spaces.

### 3.9 FEEDER CIRCUITS

- A. Provide feeders as called for on the drawings.
- B. Feeders shall be defined as any circuit originating from the main building switchboard and/or distribution panels.
- C. All feeder conductors shall be continuous from origin to panel or equipment termination without splicing.
- D. All feeders shall be conductors pulled into raceways. Cable systems are not allowed for feeders unless specifically indicated.

### 3.10 BRANCH CIRCUITS

- A. Provide all branch circuit wiring and outlets for a complete and operating system. The system shall consist of insulated conductors connected to the panelboards and run in raceways or as cable systems if permitted under products section, to the final outlet and shall include outlet boxes, supports, fittings, receptacles, plates, fuses, for a fully functional system.
- B. Provide dedicated neutrals for all lighting circuits and all circuits originating from panelboards fed from K-rated transformers.
- C. Physical arrangement of branch circuit wiring shall correspond to circuit numbering on drawings. Combining of circuits and raceways will be allowed up to a 3 phase, 4 wire circuit or 3 phase 6 wire (dedicated neutrals) in a single raceway. Any combination of homeruns such as this, however, shall be indicated on record drawings. When a common grounded conductor is used for more than one circuit, the arrangement shall be such that a receptacle, fixture, or other device may be removed or disconnected without disconnecting the grounded conductor for other circuits. Ground fault circuit breakers and isolated ground outlets shall be wired with separate neutrals and separate grounding conductors per circuit. A consistent phase orientation shall be adhered to throughout project at terminations.
- D. Circuits feeding three phase equipment shall not be combined into common raceways, unless specifically indicated.
- E. All wiring in panelboards and cabinets shall be neatly formed and grouped.

### 3.11 FIRESTOP SYSTEMS:

- A. General: Install firestop systems at all new and existing fire-rated construction where penetrated by the Work of this Section.

- B. Refer to Section 078400 - Firestopping, for all installation requirements for maintaining integrity of fire-rated construction at penetrations.

### 3.12 WATERPROOFING

- A. Waterproof all openings in slabs and walls.

### 3.13 CUTTING AND PATCHING

- A. Core drilling, up to and including 8" in diameter, and cutting equivalent to or less than the cross-sectional equivalent of 8" square shall be performed by the Electrical Sub-contractor. Sleeves and box-outs shall be provided by the Electrical Contractor regardless of size. Cutting of surfaces, including core drilling of walls and slabs, shall be done by Electrical Subcontractor. Openings through new wall surfaces will be provided by General Contractor if Electrical Subcontractor gives suitable notice as erection of surface proceeds. If suitable notice is not given, Electrical Subcontractor shall then be responsible for cost of corrective work required.
- B. Patching will be provided by the trade responsible for the surface to be patched.

### 3.14 ELEVATOR COORDINATION

- A. Elevator Electrical Work:
  - 1. Several items pertaining to elevator electrical system shall be provided by Electrical Subcontractor as follows:
    - a. Power source to elevator machine room including fused disconnect switch and wiring between disconnect switch and controller for each elevator.
    - b. Power source to elevator machine room including fused disconnect switch (120 volt) for elevator signal system and cab light for each cab.
    - c. Light, switch, and GFCI receptacle in each pit.
    - d. Light, switch, and GFCI receptacle in machine room.
    - e. Junction box in machine room with five control modules from fire alarm system for elevator recall to prevent cab opening on a fire floor.
    - f. Junction box in machine room for cab telephone with one 1 in. conduit with (2) CAT 6 telephone cables to main telephone demarcation backboard.
    - g. Power to automatic damper in hoistway penthouse louver.

### 3.15 MECHANICAL SYSTEM COORDINATION

- A. The Mechanical System Subcontractor will be providing various items of mechanical services equipment and control apparatus. Electrical Subcontractor shall furnish disconnect switches and starters and connect up power wiring to this equipment.
- B. The Mechanical and Electrical Subcontractor shall closely coordinate their respective portions of work.

- C. If, due to local regulations, electric heating equipment furnished by the mechanical systems subcontractor is required to be installed by licensed electricians in order to allow connection by Electrical Subcontractor's licensed electricians, it will then be Mechanical Subcontractor's responsibility to engage and pay for services of such licensed electricians.
- D. Power wiring to be provided by Electrical Subcontractor is the line voltage power supply wiring. Control wiring is responsibility of Mechanical System Subcontractor unless specifically indicated on electrical drawings, or in this Division of the specifications. Temperature Control Subcontractor shall refer to electrical drawings for location of all magnetic starters.
- E. 120 volt control wiring source to the temperature control panel is the responsibility of Electrical Subcontractor.

### 3.16 DISTRIBUTION EQUIPMENT TESTING

- A. All dry-type transformers, individual motor starters, switchboard and main distribution panels, motor controls, motor control centers, feeder conductors, and emergency systems shall be tested in accordance with the following. In general, all tests shall be done in accordance with the 2013 Acceptance Testing Specifications of the International Electrical Testing Association.
- B. The Testing Subcontractor may be an independent contractor or a manufacturer of the equipment, which is to be tested.
- C. Test report forms, delineating tests to be made, and method of recording same shall be submitted prior to commencing work. Test reports when submitted shall include interpretation of results and recommendation for any corrective work required.
- D. Switchboards and Main Distribution Panels:
  - 1. Visual Inspection:
    - a. Check for foreign material within bus enclosure.
    - b. Check for missing hardware.
    - c. Inspect entire assemblies for transit damage or factory defects.
    - d. Check for all bus dimensions and bracing per specifications.
    - e. Check ratings of current transformers and potential transformers.
    - f. Check ratings of all protective relays per drawings.
  - 2. Physical Inspection:
    - a. Torque all bus hardware to proper tension.
    - b. Circuit breaker interlocks all work properly.
    - c. All doors and hinged panels open and close properly.
    - d. Relay blocking removed from all control and protective relays.
    - e. All circuit breakers operate, close and trip mechanically.
    - f. Torque all feeder conductors to terminal manufacturers' recommendations.

3. Electrical Testing:
  - a. Breakers operated electrically trip and close from local and remote positions.
  - b. All circuit breakers calibrated to manufacturer's respective time current curves as specified.
    - 1) Long time pick-up amps.
    - 2) Long time delay tripping at 300 percent of current setting.
    - 3) Resets okay at 80 percent of pick-up value.
    - 4) Short time pick-up current.
    - 5) Short time delay trip time at 105 percent of setting.
    - 6) Instantaneous minimum pick-up current.
  - c. All protective relays calibrated to manufacturer's characteristic time curves for pick-up, drop-out, instantaneous and time delay.
  - d. All instruments calibrated for accuracy.
  - e. Protective relay schemes to be electrically tested by primary injection of current through current transformers and the tripping of associated circuit breakers.
  - f. Insulation resistance tests made on all circuit breakers, line to load breaker open, line to ground breaker closed, 3 poses tested individually. Switchgear bus to be tested phase to phase and phase to ground with Megohmmeter type instrument. Relays also to be insulation resistance tested.

E. Transformers:

1. Visual inspection for transit damage such as broken porcelain, brazed connections broken off, core shifted on frame, winding damage, and loose parts.
2. Insulation resistance tests in accordance with U.S.A.S.I. Standard C571222 and NEMA TRI-2.055.
3. D.C. over-potential test procedures and A.C. voltage values for factory proof testing of C57.12968 and NEMA TRI-2.055. The ratio applied for converting A.C. test potential to equivalent D.C. value is 1.6.
4. Acceptance test voltage for new transformers at D.C. value will be 75 percent of equivalent A.C. voltage used for factor proof testing the value will be 65 percent.
5. Transformers shall be subjected to a ratio and polarity test to prove the polarity and winding ratio as in accordance with nameplate specifications.
6. Torque all connections to terminal manufacturers' recommendations.

F. Starters:

1. Visual inspection to determine:
  - a. Shipping damage.
  - b. Proper bussing and contactor sizes.
  - c. Correct overload relay heater ratings. Any incorrectly sized overloads shall be replaced by the contractor who originally provided same.

2. Electrical Testing:
  - a. Electrical operation of control relays, timing relay, and contactor coils.
  - b. Insulation resistance test on all current carrying bus to ground and between phases.
  - c. Calibration check of overload heater to ascertain tripping point and time delay at 300 percent of heater rating.
  
- G. Conductors: All secondary service conductors and all feeder conductors from switchboards and distribution panels shall be tested.
  1. Visual and mechanical inspection: Conductors to be inspected for physical damage and proper connection and sizing in accordance with single line diagram.
  2. Conductor connections shall be torque tested to manufacturer's recommended values.
  3. Electrical Tests: Perform insulation resistance test on each conductor with respect to ground and adjacent conductor.
  4. Perform continuity test to insure proper conductor connection.
  
- H. Emergency Systems:
  1. Engine Generator - Prior to the emergency generator test specified under the emergency generator specification, the testing contractor shall perform the following:
    - a. Visual and Mechanical Inspection:
      - 1) Inspect for physical damage.
      - 2) Compare nameplate rating and connection with specifications and single line diagram.
      - 3) Inspect for proper anchorage and grounding. Verify engine cooling and fuel system integrity.
    - b. Electrical and Mechanical Tests:
      - 1) Perform a dielectric absorption test on generator winding with respect to ground. Determine polarization index.
      - 2) Perform phase rotation test to determine compatibility with load requirements.
      - 3) Test protective relay devices in accordance with applicable sections of these specifications.
      - 4) Perform dc over potential test between winding and ground.
  2. Automatic Transfer Switches:
    - a. Visual and Mechanical Inspection:
      - 1) Inspect for physical damage.
      - 2) Verify that the short circuit withstand rating exceeds the available short circuit duty.
      - 3) Compare equipment nameplate information and connections with single line diagram and report any discrepancies.
      - 4) Check switch to ensure positive interlock between normal and alternate sources. (Mechanical and Electrical).
      - 5) Check tightness of all control and power connections.

- 6) Perform manual transfer operation.
- 7) Ensure manual transfer warnings are attached and visible to operator.
- b. Electrical Tests:
  - 1) Perform insulation resistance tests phase-to-phase and phase-to-ground with switch in both source positions.
  - 2) Measure contact resistance in normal and alternate source position.
  - 3) Set and calibrate in accordance with the project electrical engineer's specifications.
    - a) Voltage and frequency sensing relays.
    - b) All time delay relays.
    - c) Engine start and shutdown relay.
  - 4) Perform automatic transfer by tests.
    - a) Simulating loss of normal power.
    - b) Return to normal power.
    - c) Simulating loss of emergency power on return to normal.
    - d) Simulate all forms of single phase conditions.
  - 5) Monitor and verify correct operation and timing.
    - a) Normal voltage sensing relays.
    - b) Engine start sequence.
    - c) Time delay upon transfer.
    - d) Alternate voltage sensing relays.
    - e) Automatic transfer operation.
    - f) Interlocks and limit switch function.
    - g) Timing delay and retransfer upon normal power restoration.
    - h) Engine cool down and shutdown feature.
- I. Grounding Grids or Electrodes: Measurement of resistance from ground grids or electrodes to earth to determine adequacy of grounding system in building and compliance with specifications and/or electrical code.
- J. Settings of Adjustable Devices: Using the result of the fault current and coordination study specified hereinafter, the Testing Contractor shall set all adjustable devices.
- K. In addition to the testing requirements of this Section refer to Section 019113 – Building Commissioning Requirements and Section 260800 - Commissioning of Electrical Systems for additional requirements.

### 3.17 FAULT CURRENT, ARC FLASH AND COORDINATION STUDY

- A. Employ the manufacturer of the secondary distribution equipment or an independent organization to perform a fault current, arc flash and coordination study to ensure a selectively coordinated system from the incoming mains to the branch circuit panelboards.
- B. The report shall be submitted in a standard format and shall include the fault current availability at various points in the distribution system, breaker coordination curves and recommended settings of all adjustable devices in the system.

- C. Provide appropriate labeling for all equipment as indicated in report.

3.18 STORAGE AND INSTALLATION OF EQUIPMENT

- A. The electrical subcontractor shall store and install electrical equipment and wiring listed for dry locations only after the building is watertight.

3.19 WASTE MANAGEMENT

- A. Separate and recycle materials and material packaging in accordance with Waste Management Plan and to the maximum extent economically feasible and place in designated areas for recycling.
- B. Set aside and protect materials suitable for reuse and/or remanufacturing.
- C. Separate and fold up metal banding; flatten and place along with other metal scrap for recycling in designated area.
- D. Coordinate with Section 017419 – CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

3.20 TRAINING

- A. All training shall be scheduled with the user. Training shall be videotaped and a DVD delivered to the Owner. Refer to each specific system for amount of training required.

3.21 SPARE PARTS/ATTIC STOCK:

- A. REQUIREMENTS:
  1. Provide attic stock of the following quantities and parts for each piece of equipment as follows:

Equipment/Unit	Parts Description	Quantity
LED Lights	LED Drivers	2 of each type
	Single faced exit signs	3
	Double faced exit signs	3
Fire Alarm	Smoke detectors of each type (Duct, ceiling, fire detectors)	3
	Detector	3
	Pull stations	3
	Spare printer ribbon	1
	Extra set of keys and tools for access to locked and tamperproof components	3

End of Section

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Section 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This section includes commissioning process requirements for Electrical systems, assemblies, and equipment.
- B. Related Sections:
  - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "General Commissioning Requirements" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's role.
- B. Refer to Division 01 Section "Submittals" for specific requirements. In addition, provide the following:
- C. Certificates of readiness
- D. Certificates of completion of installation, pre-start, and startup activities.
- E. O&M manuals
- F. Test reports

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

**PART 2 - PRODUCTS**

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the electrical contractor of Division 26 shall ultimately be responsible for all standard testing equipment for the electrical systems and controls systems in Division 26.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL DOCUMENTATION REQUIREMENTS**

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems
- B. Red-lined Drawings: The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. Operation and Maintenance Data: Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.
- D. Demonstration and Training: Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the Contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior to the training session

#### **3.2 CONTRACTOR'S RESPONSIBILITIES**

- A. Perform tests as required by Division 26.
- B. Attend construction phase controls coordination meetings.
- C. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CA.
- D. Provide information requested by the CxA for final commissioning documentation.
- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Electrical system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-up and task completion for owner. Distribute preliminary schedule to commissioning team members.
- G. Update schedule as required throughout the construction period.
- H. Assist the CxA in all verification and functional performance tests.

- 
- I. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
  - J. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
  - K. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
  - L. Notify the CxA a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.
  - M. Participate in, and schedule vendors and contractors to participate in the training sessions.
  - N. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
    - 1. Electrical equipment including but not limited to switchgear, panel boards, motor control centers, lighting, receptacles, dimmers and all other equipment furnished under this Division.
    - 2. Emergency generators, ATS switches and emergency power systems.
    - 3. Fire alarm system
    - 4. Lightning protection
    - 5. Grounding
  - O. The equipment supplier shall document the performance of his equipment.
  - P. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
  - Q. Equipment Suppliers
    - 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
    - 2. Assist in equipment testing per agreements with contractors.
    - 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
  - R. Refer to Division 01 Section "General Commissioning Requirements" for additional Contractor responsibilities.
- 3.3 CxA'S RESPONSIBILITIES
- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's Responsibilities.

### 3.4 TESTING PREPARATION

- A. Certify in writing to the CxA that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the CxA that Electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.5 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Electrical testing shall include the entire Electrical installation, from the incoming power equipment throughout the distribution system. Testing shall include measuring, but not limited to resistance, voltage, and amperage of system(s) and devices.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the Electrical contractor and other contracted subcontractors, including the fire alarm Subcontractor shall prepare detailed testing plans, procedures, and checklists for Electrical systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.

- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.6 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 26 sections. Provide submittals, test data, inspector record, infrared camera and certifications to the CA.
- B. Electrical Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 26 Sections "Instrumentation and Control" and "Sequence of Operations" Assist the CxA with preparation of testing plans.
- C. Emergency Generator Testing and Acceptance Procedures: Provide technicians, load banks, infrared cameras, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- D. Fire Detection and Alarm System Testing: Provide technicians, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- E. Electrical Distribution System Testing: Provide technicians, load banks, infrared cameras, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item to be tested
- F. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls as required by specifications.
- G. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

<b><i>Electrical Power Systems</i></b>
Electrical service and switchgear
Transformers

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Motor control centers
Electrical distribution systems
Emergency and standby power systems including automatic transfer switching systems
Lighting and lighting control systems
Low voltage systems
Grounding and bonding systems
Photovoltaic systems
Interfaces to automated temperature/building automation control systems
<b>Life Safety Systems</b>
Fire alarm systems
Egress lighting

3.7 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.8 APPROVAL

- A. Refer to Division 01 Section "General Commissioning Requirements" for approval procedures.

3.9 DEFERRED TESTING

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deferred testing.

3.10 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 Section "General Commissioning Requirements" for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.11 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to training.

End of Section



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Section 26 61 11  
THEATRICAL LIGHTING CONTROLS

**PART 1 - GENERAL**

1.1 SUMMARY

- A. This section includes control systems for performance lighting and house lighting.
- B. Section Includes:
1. Work in the following spaces:
    - a. Auditorium
  2. Systems:
    - a. Relay Panels
    - b. Electronics Racks
    - c. Control Consoles and Accessories
    - d. House Light Control Systems
    - e. Data Communications Devices
    - f. Performance Lighting Distribution and Control Faceplates
  3. Provision of materials, components, modifications, assemblies, equipment and services as specified herein. These include, but are not limited to:
    - a. Verification of site dimensions and conditions
    - b. Plan control system run lengths with the Electrical Contractor. Submit length take off with shop drawings. Provide cost for in-line switches and repeaters with the bid.
    - c. Submittals as required by the Contract Documents
    - d. Engineering of equipment and systems as required by the Contract Documents
    - e. Manufacture of equipment and systems as required by the Contract Documents
    - f. Coordination with the System Integrator as required by the Contract Documents
    - g. Scheduling, sequencing and coordination with other trades
    - h. Installation and supervision for equipment and systems specified herein and elsewhere in the Contract Documents
    - i. Testing and demonstration of equipment and systems as specified herein and elsewhere in the Contract Documents
    - j. Commissioning and system configuration by manufacturer's factory trained technicians
- C. Products Supplied But Not Installed Under This Section:
1. TBD
- D. Products Installed But Not Supplied Under This Section:
1. TBD

E. Related Sections:

1. Division 11: Equipment:
  - a. Section 11 61 33: Theatrical Rigging
  - b. Section 11 61 91: Theatrical Lighting Instruments and Accessories
2. Division 26: Electrical
  - a. Section 26 51 13: Architectural Luminaires, Lamps, Ballasts

1.2 REFERENCES

A. Reference Standards:

1. National Fire Protection Association (NFPA) Publication: National Electrical Code, NFPA70
2. Underwriters Laboratories Standards:
  - a. UL498, Electrical Attachment Plugs and Receptacles
  - b. UL508, Electrical Industrial Control Equipment
  - c. UL891, Dead-front Electrical Switchboards
  - d. UL1573, Stage and Studio Lighting Units
1. United States Institute for Theatre Technology Standard: DMX512-A (2008), Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories
2. ANSI Standards
  - a. ANSI E1.11 - 2008 (R2013) Entertainment Technology - USITT DMX512-A, Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories
  - b. E1.17-2015 Entertainment Technology - Architecture for Control Networks
  - c. E1.20-2010 Entertainment technology – Remote Device Management over DMX512 Networks
  - d. E1.27-2-2009 (R2014) Entertainment Technology – Recommended Practice for Installing Control Cables
  - e. E1.30-7-2009, EP129 - Allocation of Internet Protocol Version 4 Addresses to ACN Hosts
  - f. E1.31-2016 Entertainment Technology - Lightweight streaming protocol for transport of DMX512 using ACN
3. Institute of Electrical and Electronics Engineers, Inc.:
  - a. Standard: 802.3
  - b. Standard: 802.11 b or g
4. National Electric Code
5. American National Standards Institute
6. International Building Code

1.3 DEFINITIONS

- A. AHJ: Authority Having Jurisdiction

- B. DMX: Digital Multiplexing
- C. NEC: National Electric Code
- D. UL: Underwriters Laboratories, Inc.
- E. USITT: United States Institute for Theatre Technology, Inc.
- F. ESTA: Entertainment Services and Technology Association
- G. FURNISH: Deliver and hand over to others for installation
- H. INSTALL: Set in place and connect
- I. PROVIDE: Furnish and Install

#### 1.4 SUBSTITUTIONS

- A. Substitutions, changes, or deletions from the plans and Specifications will not be allowed without the prior written approval of the Architect.
  - 1. Substitution proposals from manufacturers not listed herein shall be accompanied by sufficient catalogue data, specifications, technical information, shop drawings, and samples to prove equivalence or superiority of the proposed substitution.
  - 2. If any additional wiring or conduit is required due to an accepted substitution, the Control System Manufacturer shall contract with the General Contractor to perform this additional work at no cost to the Owner.
- B. Proposals to submit bids for specific equipment by manufacturers listed herein which have been modified or improved will be considered, provided they are submitted to the Architect for approval.
  - 1. Proposals shall be accompanied by sufficient catalog data, specifications, technical information, and samples to permit proper evaluation.
- C. All questions regarding these plans and Specifications shall be referred to the Architect.

#### 1.5 SUBMITTALS WITH BIDS

- A. In addition to the submittals required under the General Conditions of these Specifications, all bidders shall submit with their bids the following:
  - 1. Current specifications and catalog cuts for the stage lighting and house lighting equipment
  - 2. Current specifications and catalog cuts for the house light control system.
  - 3. Current specifications and catalog cuts for the stage lighting control console.
  - 4. The specifications and catalog cuts furnished shall be those which were in effect on the date of issue of this Specification.
  - 5. Documentation demonstrating the existence of a seven (7) day, twenty-four (24) hour field service organization staffed by more than one (1) full time factory-trained service technician capable of making field service repair visits.
    - a. Manufacturer's representatives and/or outside technicians cannot be listed as members of the field service organization.

6. A list of at least ten (10) systems of similar scope and size which have been in service for at one (1) year.
7. A schedule with the following time estimates:
  - a. Length of time required to prepare shop drawings.
  - b. Length of time required to supply all equipment.

#### 1.6 SUBMITTALS

- A. Provide submittals in accordance with General and Special Conditions. Submit submittals in a timely manner, allowing sufficient time for adequate review and possible resubmittal without jeopardizing the project schedule.
- B. Shop Drawings:
  1. Submit shop drawings within sixty (60) days of award of contract, unless otherwise indicated in Division 1.
  2. Drawings for fabrication and installation of all products; Drawings will show all information necessary to explain fully the design features, appearance, function, fabrication, installation and use of system components in all phases of operation.
    - a. Show materials, thickness, gauges
  3. Provide relay panel schedules based on the current information from the contract documents.
  4. Fabrication, Installation, and Erection shall not commence until shop drawings have been approved by the Architect and the Theatre Consultant.
  5. Submittal shall be drawn in an 11 inch by 17-inch format.
  6. All sheets in the submittal shall be of the same size.
  7. Submittal shall include a title sheet listing all sheets in the submittal.
  8. Submittal shall include a complete bill of materials showing all items being supplied by the manufacturer and or supplier.
  9. Coordinate and document the proposed control wiring signal runs to verify run distance and limitations. Provide run length takeoffs in the shop drawing riser.
  10. Review control signal cable runs with the electrical contractor and provide guidance and wiring diagrams based on site conditions.
    - a. Wiring diagrams shall identify cable runs in excess of standard lengths and locations for in-line switches and/or repeaters.
- C. Wiring diagrams shall take advantage of control topologies to minimize conduit and cable runs.
- D. Commissioning Documentation:
  1. Certificates from the manufacturer's field engineer stating the installed system is operating properly and complies with manufacturer's recommendations
  2. Ethernet cable run certification
  3. Schedule of all tested and certified Ethernet cable run lengths
- E. Record Drawings and Maintenance Manuals:

1. Operations and Maintenance Manuals (O&M) shall include:
  - a. As-built drawings
  - b. Final relay and associated panel schedules including DMX, sACN and EDMX addressing
  - c. Contact information for pertinent manufacturers
  - d. Safety and Operational Instructions
  - e. Complete parts and subassembly list
  - f. Software version information
  - g. Wiring diagrams and termination schedules
  - h. Periodic Maintenance Schedule
  - i. A maintenance procedure for finishes
  - j. Certificates of compliance with applicable codes
  - k. Records of final testing and log
  - l. Spare parts list and source information
  - m. Warranty documentation
  - n. Provide the above in universal electronic format files; pdf file type is preferred, as full-size printable sheets. Submit files on standard pc format CD clearly labeled including project name, project architect, theatre consultant, contractor name, date of submittal.
2. Bind all O&M documentation separate from general building sections so they can be turned over to the users after approval.
3. Provide draft copy of completed manuals for review to the Theatre Consultant before the start of commissioning.
4. Include diagrams depicting the system layout and interconnections. Reduced size, 11 by 17-inch preferred.
5. Provide three (3) copies of operation manuals
6. Provide two (2) copies of each system configuration on CD

#### 1.7 QUALITY ASSURANCE

##### A. Qualifications:

1. Manufacturer: A firm who has been continuously engaged in the production of theatrical lighting and control equipment for at least fifteen (15) years and in the manufacture of theatrical control and dimming systems for a minimum of ten (10) years.
2. Installer: Skilled technicians who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and best industry practices for the proper installation of the work

##### B. Manufacturer shall provide a twenty-four (24) hour emergency service phone line.

1. A field service engineer shall respond to an emergency call on this line within thirty (30) minutes.

## 1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver equipment and controls securely wrapped in factory fabricated wooden or fiberboard containers.
- B. Handle equipment and controls carefully to prevent breakage, denting and scoring finish. Do not install damaged equipment and controls; replace and return damaged units to equipment manufacturer.
- C. Acceptance at Site: Contractor shall accept and inventory all equipment upon delivery and provide copies of the inventory to the architect.
- D. Storage and Protection: Store equipment in a secure, environmentally controlled location. Place no equipment until that location is substantially completed, free from construction dust, and "broom clean." Store in original cartons and protect from dirt, physical damage, weather, and construction traffic.
- E. The Control System Manufacturer shall coordinate delivery of all equipment with the Electrical Contractor.
  - 1. If required by the Electrical Contractor, control system equipment shall be delivered in a minimum of three (3) separate shipments based on Electrical Contractor requirements.
  - 2. Minimum shipment increments shall include:
    - a. Shipment #1: All items in which conduit is terminated. This shall include dimmer racks, relay cabinets, line voltage and control station back boxes.
    - b. Shipment #2: All items in which wiring is terminated. This shall include control station faceplates, etc.
    - c. Shipment #3: All items that are not required until the system activation by the Control System Manufacturer's field service representative. This shall include dimmer modules, electronics modules, control consoles, monitors, focus remote, cables, portable control stations, etc.
    - d. Control System Manufacturer shall schedule shipment #3 based on discussions with the Owner.
    - e. If shipment #3 items are delivered to the job site prior to the agreed upon schedule, the Control System Manufacturer shall be responsible for providing storage for these items until they are required on the job site.

## 1.9 PROJECT CONDITIONS

- A. Field Measurements: Contractor is to verify all dimensions as they relate to requirements of the specification and manufacturer's requirements, and is to notify the Owner's Representative of any variations, which would affect the installation and safe operation of the systems.
  - 1. Coordinate the proposed control wiring signal routes to verify run distance and limitations.

## 1.10 SCHEDULING AND SEQUENCING

- A. Provide a project schedule at time of contract award, indicating critical path for installation of these systems and coordination with other trades.

- B. Coordinate with Electrical contractor for the provision of conduit for electrical power and control wiring.

#### 1.11 WARRANTY

- A. Special Warranty:
  - 1. Provide warranty for systems and equipment to be free of defective components, faulty workmanship, and improper adjustment for a period of two (2) years from the date of substantial completion or acceptance by the Owner, whichever is later. Paint and exterior finishes are excluded. Replace items showing evidence of defective materials or workmanship (including installation workmanship) within thirty (30) days after notification. Make replacements without cost to the Owner.
  - 2. Rectify conditions that might present a hazard to human life, well-being, or property within forty-eight (48) hours of notification.
- B. Designate warranties on manufactured equipment to the Owner to commence on the date of system acceptance.

#### 1.12 COMMISSIONING

- A. Provide demonstration and testing of systems described in this section.

#### 1.13 MAINTENANCE

- A. Maintenance Service: Provide maintenance service for a period of two (2) years after final acceptance of the installation. This service shall cover parts and labor. This service consists of at least two (2) half-yearly visits to the site for checking and adjusting of equipment. Perform the first visit six (6) months after the system has been accepted.
- B. Continuing Service Proposal: At time of bid, provide a separate proposal for continuing annual service visits to the installation for inspection and maintenance of the supplied systems.
  - 1. Provide a proposal for the first visit to occur two (2) years after the date of hand-over and to continue for five (5) years after the date of commencement.
  - 2. The proposal shall remain valid and extended until the date of hand-over, at which time the Owner may accept or reject the proposal without prejudice.
  - 3. Warranty site visits, as specified in the Contract Documents, are specifically excluded from the Continuing Service Proposal.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS

- A. Provide the control systems from components (except where otherwise stated) that are the products of one of the following manufacturers:
  - 1. Electronic Theatre Controls, Inc., Middleton, WI - (608) 831-4116
  - 2. MA Lighting (managed by A.C.T. Lighting) – (201) 996-0884
  - 3. Strand Lighting (Signify), New York, NY (401) 374 3319

## 2.2 SPECIALTY SUBCONTRACTORS

- A. The systems described herein shall be provided by a single contractor. The following subcontractors are pre-approved bidders for work contained in this specification:
1. Barbizon Lighting, Woburn, MA – (781) 935-3920
  2. Candela Controls, Bill Ellis, Winter Garden, FL – (407) 654-2420
  3. High Output, Canton, MA – (781) 364-1812
  4. Main Stage, Pensacola, FL – (800) 851-3618
  5. Starlite, Moorestown, NJ – (800) 738-7400
  6. Limelight Productions, Lee MA, - (800) 243-4950
- B. Other Contractors wishing to bid must submit qualifications to the Architect, Theatre Consultant, and Client for approval prior to bid.
1. Requirements:
    - a. Specialty Subcontractor and the individuals responsible for installation in the field shall have been continuously engaged in the sales and integration of power distribution and control equipment similar to that specified herein for a minimum of ten (10) years and shall have completed at least eight (8) installations of this type and scope.
    - b. Specialty Subcontractors shall have at time of bid and continuously maintain throughout the project and warranty period a Specialty Contractor's license appropriate for work in this Section.

## 2.3 MANUFACTURED UNITS

- A. Control Consoles
1. General:
    - a. Control consoles to be provided by same manufacturer as control system.
    - b. Provide software current at time of installation.
      - i. Provide a minimum two (2) year subscription to update all performance lighting console software such as fixture libraries, visualization software, and related lighting paperwork.
    - c. Console shall be configured to be a node on the lighting network and shall be ACN compatible.
    - d. Software Features:
      - i. Capacity to display the following screens
      - ii. Stage (live) - Levels currently active on stage
      - iii. Preview (blind) - Levels recorded in a preset
      - iv. Softpatch - Patching information
      - v. Setup configuration - Basic operating parameters
      - vi. Disk read, write and format
      - vii. Clear show



- viii. Setup Parameters
  - ix. Default Fade Time
  - x. Dimmer configuration
  - xi. Channel configuration
  - xii. Hardware configuration
  - xiii. Print Functions:
    - a. Stage Display
    - b. Cues
    - c. Submasters
    - d. Patch
  - xiv. Patching:
    - a. Proportional patching of dimmers to channels of control
  - xv. Recording
  - xvi. Channel list constructed with AND and THROUGH functions
  - xvii. Proportional adjustment of current channel list with level wheel
  - xviii. Setting of levels with AT function
  - xix. Release of channel list without modification
  - xx. Recording of stage or blind settings
  - xxi. Cue numbers between 000.1 to 999.9
  - xxii. Non-sequential recording
  - xxiii. Cue time fades of 1 to 99 seconds
  - xxiv. Split fade up and down times
  - xxv. Cue linking allowing cues to automatically follow each other
  - xxvi. Link delay time
- e. Playback:
    - i. Pairs simultaneously timed cross fades, pile-on fades, and split fades
    - ii. Last action within each fader pair
    - iii. Highest level between fader pairs
    - iv. Capacity to override, halt, or release halted fades
    - v. Discrete overriding of each half of a fader pair
  - f. Submasters:
    - i. Totals specified herein shall be for physical faders. Digital "soft" submasters or pages of submasters shall not count to the total specified.
    - ii. Submasters are overlapping in a highest takes precedence fashion.
    - iii. Each submaster has a bump button which forces channels assigned to that submaster to their recorded level.

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- iv. Submasters are recorded live or blind.
      - v. Proportional control of assigned levels
      - vi. Capacity to build cues from submasters
    - g. Effects package including:
      - i. Effects built from submasters
      - ii. Variable one (1) to six (6) part chase
      - iii. Level and rate control of chase
    - h. On-line help information
  - 2. 500 Channel Performance Lighting Console
    - a. Minimum Basic Capacities:
      - i. One thousand twenty-four (1,024) outputs
      - ii. Five hundred (500) control channels
      - iii. Ten thousand (10,000) cue memory capacity
      - iv. Forty (40) submasters
    - b. Hardware Features:
      - i. Two (2) black 19-inch touch screens
      - ii. One (1) remote focus port
      - iii. One (1) Ethernet port
      - iv. Operating software stored in upgradeable, internal non-volatile memory.
      - v. Show data storage in battery backed up random access memory
      - vi. One (1) internal hard drive unit for library storage
      - vii. Extended numeric keypad for entering dimmer, channel, submaster, preset, level, time and link instructions
      - viii. One alpha-numeric keyboard for notating cue information
      - ix. Display keypad to provide access to display settings
      - x. Level wheel (or pad) for proportional intensity control over user selectable channels
      - xi. Two (2) electronically timed cross faders with manual override, each with a fade time status display, HOLD, CLEAR, GO BACK and GO functions
      - xii. Proportional Grand master
      - xiii. Receptacles for plug-in dimmer control cables
      - xiv. AC power cable and a set of 25'-0" control cables with connectors
    - c. Acceptable products:
      - i. Basis of Design: Electronic Theater Controls – Element 2 – 1K
- B. Console Accessories - Refer to the schedule herein for quantities:
- 1. Remote Focus Unit:
    - a. Provide portable units capable of calling up dimmers, channels, cues and submasters.

- b. Provide console with wired remote focus units as listed herein.
  - c. Provide each wired unit with one (1) 25-foot control cable and one (1) 50 foot extension cable.
  - d. Device shall be capable of calling up dimmers, channels, cues and submasters.
  - e. Provide spare battery and charger for each handheld portable.
2. Console Desk:
- a. Provide roll top console stand suitable for use at lighting control room observation window.
  - b. Acceptable Products:
    - i. Basis of Design: Chief Raxxiss Roll Top Desk ERT-CHSD
3. Dust Covers:
- a. Provide standard dust covers
    - i. Provide for each console
    - ii. Provide for each video monitor/display.
  - b. Acceptable Products:
    - i. Basis of Design: OEM
4. Refer to the schedule herein for quantities
- a. Back-up data storage:
    - i. Provide two (2) 256GB USB flash drives per console.
- C. House Light Control System
1. General:
- a. Provide an integrated House Light Control system. The system is capable of controlling performance and house lighting through local and master control stations.
    - i. Coordinate with Electrical Engineer, Architectural Lighting Designer and System Integrator (if any) for DMX addressing requirements. Provide processors with capacity for the total of all DMX assignments required for controlling architectural LEDs to their finest resolution.
  - b. House/Work Light Controls and Control Console have simultaneous "pile on" control of dimmers and relays as shown on the Drawings.
  - c. System is programmable using a laptop computer or designated LCD touchscreen control stations.
  - d. User interface is through pushbutton and or LCD touchscreen control stations.
  - e. Provide relays and circuit breakers based on zone designations. Relays shall not be ganged on individual circuit breakers.
2. Standard Operating Features:
- a. Control system allows cross fading between presets within each of multiple rooms.
  - b. Presets can mirror between stations.

- c. System parameters are user configurable. These parameters include but are not limited to current date, current time, dimmer type, high level limit, control station name, preset names, presets, mirror designation, lockout modes, dimmer assignments per channel, preset master names, station numbers, channel levels, and station names.
  - d. System accepts dry closures from external sources. Closures shall be momentary alternate action turning channels or presets on or off.
  - e. Fade times on each preset are adjustable from 0 - 999 seconds.
  - f. Preset masters are available to control groups of presets throughout the system.
  - g. Presets shall be programmed to be recalled from the AV system control panel.
  - h. Programming of 8 presets is required. Presets to be stored in the houselight processor.
  - i. Provide RS232 serial cable connection to the AV control system.
  - j. Preset masters shall also provide "template" ability whereby station activation or control parameters maybe changed.
  - k. System provides disk storage of configuration and lighting data.
  - l. Provide Architectural lighting program to owner for future changes to system configuration.
3. Pushbutton Stations:
- a. Provide pushbutton stations with the following minimum capabilities and equipment:
    - i. Each pushbutton may be configured to control a single channel or a single preset as required.
    - ii. Each pushbutton may be configured either to toggle a preset or channel on and off or to initiate a crossfade to another preset as required.
    - iii. Each pushbutton may be configured to allow resetting of the channel or preset intensity by holding the pushbutton until the preset or channel fades to the desired level and releasing the pushbutton to store the new level.
    - iv. Faceplate signage is screened as per Contract Documents. Each pushbutton station may be configured to control multiple channels or presets as required by the different states for which the system is configured.
    - v. Station shall fit into a standard single gang wall box for recessed installation.
    - vi. Provide painted steel backbox sized to faceplate dimensions for surface installation.
    - vii. Provide LED indicators programmable as locator lights, station active pilot lights, or station enabled pilot lights.
4. LCD Touchscreen Stations:
- a. All LCD touchscreens should be 7-inch minimum Active Matrix type screens.
  - b. Custom configure LCD touchscreens to project requirements.
  - c. Station shall provide up to 128 presets.
  - d. Station shall be able to address individual dimmers and relays within a preset and modify levels and fade times.
  - e. Multiple LCD touchscreen control stations shall mimic and control shall be last action takes precedence.

- f. Provide programming, patching and recording ability from Lighting Control Room stations.
  - g. Provide LCD Screen graphics and functionality as shown on the Contract Drawings.
  - h. Provide painted steel backbox appropriately sized for recessed installation.
  - i. Provide painted steel backbox sized to faceplate dimensions for surface installation.
  - j. Provide lockable cover as shown on faceplate drawings.
5. Portable LCD touchscreen (portable console):
- a. Provide portable panel in a table top console with 25 foot control cable for each space with a dedicated house worklight control system.
  - b. Master states shall be user configurable via external PC and shall include the ability to:
    - i. Lock out or enable control stations
6. Control Station Material and Finish:
- a. Material: 1/8 inch aluminum
  - b. Finish: "Black" or "Custom" as indicated on the Drawings.
    - i. Black finish: 120 grit, horizontally brushed black anodized
    - ii. Special finish: Powder coat painted finish
  - c. Legends: Engraved and paint filled as shown or as directed.
  - d. Reinforce faceplate as needed to minimize deflection.
7. Configure the system to provide no delay time between the toggle "on" position and the illumination of the lighting fixture and the reporting back to the station.
8. Acceptable Products: Subject to the above requirements, provide one of the following products:
- a. Basis of design: Electronic Theatre Controls Unison/Paradigm
- D. DMX Driven Relay Panels (Intelligent Panel Board System)
1. General:
- a. Breaker Panels shall be UL Listed and labeled.
  - b. Breaker Panels shall consist of a main enclosure with breaker subpanels, integral control electronics, and provision for accessory cards.
    - i. Up to three accessory cards shall be supported per breaker panel
      - a. Panel shall be network enabled
      - b. Panel shall have ride thru option
2. Provide signage on the relay panels with the following attributes:
- a. Material: 1/8-inch black lamacoid
  - b. Finish: Black with white fill
  - c. Engraving: 3/8-inch-high characters with non-yellowing white fill
  - d. Indicate the following on the sign:

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Project:	Project Name
Theatre Consultant:	Theatre Projects
Manufacturer:	Company Name city, state and service telephone number

- e. Rivet to front on one (1) relay panel in each dimmer/relay room.
3. Control Features:
- a. Standard control format is DMX-512.
    - i. Addressing shall be set via the user interface button keypad with any circuit patched to any DMX control address.
    - ii. The breakers shall respond to control changes (DMX or Stations) in less than 25 milliseconds. DMX512 update speed shall be 40Hz.
    - iii. Setting changes shall be able to be made across all, some, or just one selected breaker in a single action from the face panel
    - iv. DMX data loss shall allow for levels/breakers to be held for ever or for a specified time before switching to a lower priority source
  - b. Initial Panel setup
    - i. The breaker panel shall automatically detect the type of breaker installed in each location without need for manual configuration of the physical arrangement.
    - ii. Quick rack setup shall be available to apply address settings across all circuits for rack number, DMX Start Address, sACN universe, and sACN start address.
    - iii. Emergency Setup Menu shall provide optional delays when emergency is activated or deactivated, and option to turn off non-emergency circuits shall be available. Record function shall allow circuits that are turned on to be added to the emergency setting.
4. User Interface:
- a. The user interface shall contain a graphical display with button pad to include numeric entry, navigation arrows and enter.
  - b. Test shortcut button shall be available for local activation of preset, sequence and set level overrides.
  - c. The user interface shall have a power status LED indicator, a DMX status LED indicator, a network status LED indicator, and an LED indicator for errors.
  - d. Ethernet interface shall be installed and shall default to automatic IP through link local and DHCP. Upon receiving IP address, the address of the Network Interface Card (NIC) shall display in the about menu. Static address and settings shall also be possible.
  - e. The control interface shall support a USB memory stick interface for uploads of configurations and software updates.
5. Functional:
- a. Panel setup shall be user programmable. The control interface shall provide the following breaker setup features (per circuit):
    - i. Type (1 pole, 2 pole, or 3 pole)
    - ii. Name

- iii. Circuit Number
  - iv. DMX address
  - v. sACN address
  - vi. Space Number
  - vii. Circuit Modes
  - viii. Include in UL924 emergency activation
- b. Breaker panels shall support discrete addressing of each breaker.
- i. The panel shall be capable of switching 6 poles on or off at once, or in a user-selectable delay per breaker using a period of 0.1 to 60 seconds, in 0.1 second increments
  - ii. Control electronics shall report the following information per branch circuit:
    - a. Breaker state (On/ Off)
    - b. Breaker state (Open/ Closed)
    - c. Current draw (In Amps)
    - d. Voltage
    - e. Energy usage
  - iii. Built in Control shall include:
    - a. Ability to record up to 16 presets in each space from the control panel, connected control stations, or timed events
    - b. Presets shall be programmable by recording current levels (as set by DMX or connected control stations), by entering levels on the control panel directly, manually selecting breaker state on each breaker, or a combination of these methods. From the control panel, stations, or timed events it shall be possible to record values for up to 16 zones per space.
    - c. Indication of an active preset shall be visible on the control panel display.
    - d. One 16-step sequence per space for power up and power down routines
    - e. The panel shall have a UL924-listed contact input for use in Emergency Lighting systems. The panel shall respond to the contact input by setting included breakers to "on", while setting non-emergency breakers "off". Each breaker can be selected for activation upon contact input.
    - f. Upon data loss, the system shall provide options to hold last look infinitely or hold for a configured time period set by the installing technician then fade/switch to the input of the next available priority.
    - g. Control electronics shall respond directly to control stations for zone, preset, and sequence control. Systems that require secondary control systems for this functionality are not acceptable.
    - h. After power loss, electronics shall be capable of holding the system in its previous state until new level data (DMX, architectural presets, sequences and zones, or local overrides) is received to make each breaker change state.
6. Electrical:
- a. Breaker Panels shall support power input from:

- i. 120/208V three phase 4-wire plus ground
  - b. Breaker:
    - i. Bus connection type: Stab on
    - ii. 1, 2, or 3 poles
    - iii. 15 amp, 20 amp, or 30 amp
    - iv. 22,000 SCCR; 65,000A series rated w main breaker
    - v. High inrush trip curve
    - vi. Maintains trip curve through entire thermal range
    - vii. Guaranteed not to trip at full load
    - viii. Load lugs accept 6-18awg load wiring
    - ix. Multi-conductor rated output terminal
    - x. Integral mechanically held air gap relay
    - xi. Manual control of relay state using breaker handle w/o power
    - xii. Integral current sensing
    - xiii. Integral position and trip sensing
    - xiv. Control and status provided by contact pads directly at bottom of the breaker case.  
No external wires or connections required for control or feedback
    - xv. The breaker panel shall support a maximum feed size
      - a. 400 Amps at 48 circuits
  - c. Breaker panels shall support main circuit breaker options:
    - i. Main breaker options shall be available
    - ii. Main breakers shall be field installable
    - iii. Main breakers shall allow the following range of wire sizes:
      - a. Up to 300kcmil at 100A and 200A
      - b. Up to 600kcmil at 400A
    - iv. Main Lug input shall support up to 2x200kcmil
7. Accessories for use as emergency lighting panel
- a. Provide power loss sensing device, by-pass option, UPS battery backup and other accessories to configure standard relay panel for use on a normal/emergency feed.
  - b. At time of power loss relay panel control module shall switch all relays within that panel on.
  - c. Refer to the electrical drawings for relay panel assignments to emergency lighting use.
  - d. Acceptable Products:
    - i. Electronic Theatre Controls - Sensor IQ Intelligent Panelboard System

E. Data Communications



1. Provide a fully functioning Performance lighting Ethernet system. Install the system in conformance with the latest ESTA and IEEE 802.3 standards and the control console manufacturer's requirements.
  - a. Uninterrupted power supply (UPS) Power filtration/line regulation/battery backup with the following minimum capacities:
    - i. Input voltage < 132 V AC
    - ii. Output voltage 115 V AC  $\pm$  5 percent
    - iii. Transfer voltage 103 V AC
    - iv. Surge energy 240 J
    - v. Surge current 6500 A peak
    - vi. Surge response time 0 ns (instantaneous)
    - vii. Noise filtration, full time EMI/RFI suppression, 100 kHz to 10 MHz, > 60 dB
    - viii. Audible low battery signal
    - ix. Minimum of ten (10) minutes back-up time
2. Provide Cat-6a green jacketed cable to identify the lighting control network.
3. Coordinate the wireless Ethernet protocols with other areas of theatrical production (Sound, Rigging and Automation, and Administration) to ensure that the theatrical lighting system has its own dedicated secured channel and does not broadcast SSID information that would allow the system to be compromised. Set up MAC address filtering if nearby networks require it.
4. Control (Aux) Rack
  - a. Provide standard wall-mounted, hinged 19 inch control rack(s) with sufficient space to accept devices as shown on the drawings.
  - b. Control Rack Accessories
    - i. Locking door
    - ii. Regressing brackets to permit the door to close with connectors patched to devices.
    - iii. Blank panels to fill all spaces
  - c. Provide signage on the Aux rack with the following attributes:
    - i. Material: 1/8-inch black lamacoid
    - ii. Finish: black with white fill
    - iii. Engraving: 3/8-inch-high characters with non-yellowing white fill
    - iv. Indicate the following on the sign:

Project:	Project Name
Theatre Consultant:	Theatre Projects
Manufacturer:	Company Name City, state and service telephone number

- v. Rivet to front on one (1) Aux rack in each dimmer/relay room.
5. 24+2 Gigabit Ethernet Switches-PoE / Patch Panels:

- a. Provide managed switches and patch panels of a high quality from a company with five or more years of experience manufacturing this equipment.
- b. All Gigabit Ethernet switches shall be Power-over-Ethernet units capable of operating standard and fast Ethernet protocols.
- c. The switch shall include the following connections:
  - i. Qty. 24, 10/100/1000BaseT ports with 802.3af Power over Ethernet
  - ii. Qty. 2, 10/100/1000BaseT ports
  - iii. Qty. 2, mini-GBIC (SFP) ports fitted with 1000BaseSX Fiber Optic module
- d. Label switches and patch panels with the locations of the field boxes and as labeled in the box schedules.
- e. Provide proper quantity of Category 6 patch cables to patch all field devices to hubs/switches.
- f. All wireless switches must comply with latest IEEE 802.3 b/g standards and are to be installed using best industry practices.
- g. Provide web browsable switches that can be accessed through any commercially available web browser.
- h. Provide in-line switches based on proposed and actual cable run lengths.
- i. Provide rack mounted power filtration/line regulation/battery backup unit (as specified herein) for each hub/switch.
- j. Acceptable switch manufacturers:
  - i. Basis of design:
    - a. Hewlett-Packard – Procurve series, 3000 Hanover Street, Palo Alto, CA
    - b. Cisco Systems – 300 series, 170 West Tasman Drive, San Jose, CA

6. Ethernet Nodes:

- a. Provide the latest products available from the control console manufacturer at the time of installation.
- b. Ethernet Nodes to be sACN compatible.
- c. Provide rack mounted dual four port nodes in each aux rack for DMX output. See drawings for quantities.
- d. Provide control cable packages as listed in the schedule in Part 3 of this section.
- e. Acceptable Products:
  - i. Basis of design:
    - a. Electronic Theatre Controls - Net3 Gateways

F. Distribution and Control Faceplates and Back Boxes

1. Provide line voltage and control faceplates and back boxes as shown in the TL-series drawings.
2. General:
  - a. For surface mounted conditions faceplate and back box dimensions are equal.

- b. Remove sharp edges and burrs on faceplates.
- c. In all cases faceplate screw color is to match faceplate color.
- 3. Distribution (Line Voltage) Faceplates:
  - a. Material: Minimum 14-gauge steel
  - b. Finish: "Black" or "Custom" as indicated on the Drawings
    - i. Black finish: Powder coat flat black enamel
    - ii. Special finish: Powder coat painted finish to match Architect's sample
  - c. Provide terminal strips as needed for connection of wiring within pigtail boxes.
  - d. Reinforce faceplates as needed where deflection may occur under heavy use.
  - e. Provide a removable label on the faceplate designating the box number as shown in the drawings.
  - f. Label each faceplate with circuit numbers as shown on the Drawings and Schedules.
    - i. Material: 1/8 inch black lamacoid
    - ii. Finish: Black with non-yellowing white fill
    - iii. Engraving: 1/2 inch high characters with non-yellowing white fill
    - iv. Attach labels to the faceplate with appropriate adhesive and rivet to faceplates.
  - g. Label the inside back of each box with an arrow indicating the "up" position.
  - h. Label the outside top of each box with a removable OSHA yellow sticker with a minimum of 1-inch high lettering indicating the "up" position.
  - i. Fill unused pre-drilled mounting holes.
  - j. Label each pigtail connector with circuit number, unless otherwise indicated.
    - i. Directly engrave into cover of connector in 1/2-inch-high characters with non-yellowing white fill.
  - k. Flexible Cable:
    - i. Type SO sized to accommodate the maximum load of the terminating connector
    - ii. Color: Black
- 4. Control Faceplates:
  - a. Material: 1/8-inch aluminum
  - b. Finish: "Black" or "Custom" as indicated on the Drawings
    - i. Black finish: 120 grit, horizontally brushed black anodized
    - ii. Special finish: Powder coat painted finish to match Architect's sample
  - c. Reinforce faceplate as needed to minimize deflection.
  - d. Legends: Engraved and paint filled as shown or as directed.
  - e. Provide a removable label on the faceplate designating the box number as shown in the drawings.
  - f. Faceplate shall fit into standard sized gang wall box for recessed installation.
  - g. Provide painted steel backbox sized to faceplate dimensions for surface installation.

- h. Receptacles
  - i. XLR
    - a. Neutrik DL series black metal housing XLR with silver contacts or equal
  - ii. Ethernet
    - a. Neutrik etherCON D Series black metal housing RJ45 or equal

5. Acceptable Manufacturers:

- a. Electronic Theatre Controls
- b. TMB Associates
- c. Lex Products
- d. Union Connector

G. DMX isolated Splitter

- 1. Five (5) outputs minimum
- 2. Termination switch
- 3. 2500V opto isolation between input and output signals
- 4. 250V fault protection
- 5. Provide pipe mount accessories
- 6. RDM compatible
- 7. Acceptable Manufacturers:
  - a. Basis of design:
    - i. Pathway Connectivity Solutions
    - ii. Doug Fleenor Design

2.4 ACCESSORIES

- A. Provide two (2) copies of associated manuals.
- B. Configuration Documentation:
  - 1. Provide two (2) copies of each system configuration on the USB flash drive.

2.5 SUPPLEMENTARY

- A. Provide equipment and hardware in addition to the items specified previously that are necessary to provide a fully working system in conformance with the intent of the Contract Documents.

**PART 3 - EXECUTION**

3.1 EXAMINATION

- A. Examine areas where performance controls are to be installed and to verify that conditions are satisfactory for installation and comply with manufacturer's requirements and those specified in this section.

- B. Lighting control electronics shall not be installed in rooms where the interior finishes are not complete.
  - 1. Control rooms and performance electrical rooms shall be broom clean and free of debris.
  - 2. Do not proceed with installation until unsatisfactory conditions have been corrected.
- C. Examine drawings and confirm that number, size, and location of conduits are adequate for proposed system.
- D. Review the network cables runs and provide in-line switches and power for runs exceeding 300 feet.

### 3.2 INSTALLATION

- A. Install performance lighting and controls where shown, in accordance with manufacturer's written instructions and with recognized industry practice to ensure that performance lighting equipment complies with applicable requirements of NEC and UL standards and with the applicable portions of NECA's "Standard of Installation."
- B. All load circuit conductors shall be continuous from the performance electrical rooms to the back box without splices or connectors.
- C. All data wiring shall be continuous from termination point to termination point. No splices or connectors allowed.

### 3.3 FIELD QUALITY CONTROL

- A. Provide or facilitate the following tests or inspections. Correct deficiencies and retest deficient items.
- B. Visual and Mechanical Inspections: Include the following:
  - 1. Inspect each receptacle, and other loose items of equipment for defects, finish failure, corrosion, physical damage, labeling, and nameplate.
  - 2. Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's instructions or routine functional operation.
  - 3. Check tightness of electrical connections with torque wrench calibrated within the previous six (6) months. Use manufacturer's recommended torque values.
  - 4. Verify proper protective device setting and fuse types and ratings.
- C. Electrical Tests: Perform according to manufacturer's instructions. Exercise caution testing devices containing solid state components.
  - 1. Operational and continuity tests of all circuits. Perform an outlet by outlet operational test of the relay circuits to determine proper wiring and exact correspondence between the circuit numbers and the receptacle labels.
  - 2. Operational tests of Ethernet runs: Test each Ethernet wiring run for proper operation in conformance with the IEEE standard. Document the length of each run.
- D. Manufacturer's Field Service:

1. Provide the services of a qualified service representative, employed regularly and full time by the manufacturer of the control system(s), to check the installation of the control system(s) and ensure its proper operation. Do not energize any part of the control system until their check is complete and the service representative is present to observe the turn-on procedure.
2. Provide manufacturer's technician to configure house/work lighting control system as directed prior to system commissioning. One (1) set of changes to the initial operating configuration may be required subsequent to commissioning. One (1) set of changes will be required following acceptance.

E. Pre-Commissioning Test

1. Organize and conduct a test of the DMX addressing for the house and work light system.
2. Verify fixtures and racks have been addressed according to the coordinated DMX addressing table.
3. Schedule the pre-commissioning test upon completion of the DMX addressing.
4. Notify the architect fourteen (14) days prior to the test.
5. Provide field technicians and equipment required to address fixtures to their assigned resolution. The computer, if used in place of the console, shall have the ability run timed, simultaneous fades of all DMX addresses.
6. Store finalized DMX addressing scheme on the control processor and at an off-site location.

F. System Commissioning:

1. Upon completing installation, other tests, and manufacturer's check-out, schedule an inspection and operating test with the Architect. Facilitate such tests as may be required to ensure that all equipment is in compliance with the intent of the specification.
2. Upon completion of the installation, and before scheduling the system inspection with the Architect and Architectural Lighting Designer, the Electrical Contractor shall confirm the following in writing:
  - a. Theatrical load circuits have been tested and are operational.
  - b. Data circuits have been tested and are operational.
  - c. Architectural control stations installed and are operational.
  - d. Architectural lighting loads are terminated, operational and assigned addresses per the contract documents.
  - e. Loose equipment is on site and located in the control room for each performance space. Equipment should be secured within these control rooms to prevent theft, or damage from construction debris.
  - f. If any of the above items are found to be incomplete after receipt of notification, the Electrical Contractor shall reimburse expenses including labor, travel, hotel and meals.
3. Comply with the following conditions required for commissioning:
  - a. Provide documentation to the Architect certifying all Ethernet outlets adhere to IEEE standards.
  - b. Loose equipment provided under this section to be on site and available for testing.
  - c. All architectural lighting fixtures wired to the control system shall be installed and lamped.

- d. Provide full and uninterrupted access to stage, auditorium, and technical areas required for commissioning tests. Blackouts of lighting will be required.
  - e. Contractor's project representative to be present during tests as required.
  - f. Provide Manufacturer technicians for final programming of all systems.
  - g. Manufacturer's factory field technician to be present during tests and inspections.
  - h. Provide personnel to operate equipment and perform adjustments as necessary.
  - i. Provide access equipment as required.
  - j. Provide four (4) stations of professional quality radio communication and battery charging station.
    - i. Provide a headset for each station.
4. Contractor is required to facilitate the Consultant/Architect commissioning of the Control system. This commissioning will include but is not limited to the following items.
- a. Verify that loose and installed equipment quantities are as contracted.
  - b. Inspect all system components individually for conformance to specification.
  - c. Test each branch circuit for operation, correct circuit identification, and proper arrangement of hot, neutral, and ground conductors.
  - d. Spot test selected branch circuits at maximum load.
  - e. Verify operation of all houselight fixtures. Test operation of all houselight control devices. Verify that logical operation of controls is as specified.
  - f. Verify operation of all portable control and portable display devices from all associated receptacle locations.
  - g. Using a DMX source, verify operation of DMX distribution network.
  - h. Confirm the proper operation of the lighting Ethernet system.
  - i. Review operation, maintenance, and instruction manuals. Review warranty certificate.
  - j. Confirm that user training has/will occur per specification.
5. Notification to the Architect a minimum of fourteen (14) days prior to date of inspection that installation is complete and that all building systems and conditions have been met for complete testing is required before a specific commissioning date will be confirmed.

### 3.4 CLEANING

- A. Remove paint splatters and other spots, dirt, and debris.
- B. Repair scratches and mars of finish to match original finish.
- C. Clean devices and equipment internally and externally using methods and materials as recommended by manufacturers.

3.5 DEMONSTRATION AND INSTRUCTION

- A. The manufacturer of the system shall provide a minimum of twenty (20) hours of training in the operation of the control console, architectural control system, and other related systems specified herein. These sessions shall consist of five (5) – four (4) hour sessions at times separate from the check-out of the systems. Training time to be arranged with the staff of the facility and shall take place over the first six (6) months after building acceptance. These training sessions cannot be *completed consecutively and should be separated by no less than 1 month or as directed by users.*
- B. Provide digital video of training for Owner’s use in future training sessions.

3.6 CONTROL EQUIPMENT SCHEDULE

- A. The following schedule includes off-the-shelf equipment for the lighting control system. Provide equipment and hardware in addition to the items specified that are necessary to provide a fully working system.
  - 1. Provide unit pricing for items noted in the following schedule.

ITEM #	DESCRIPTION	Unit Pricing Required	Quantity	Grand Total
	500 channel lighting console		1	
	19 inch flat screen touch panels		2	
	Worklight		1	
	USB flash drive		1	
	UPS		2	
	Roll Top Console Desk		1	
	Hardwired Remote Focus Unit		1	
	2-port network nodes with Mega Clamps		1	
	10 foot Network cable TMB CAT6A Neutrik EtherCon connectors			
	25 foot Network cable TMB CAT6A Neutrik EtherCon connectors		1	
	50 foot DMX Cable TMB PC224P Neutrik 5pin XLR		1	
	DMX gender bender male-to-male		1	
	Portable LCD Touchscreen (portable consolette)		1	

Note: Schedule is not all inclusive, refer to body of specification for additional equipment required.  
 End of Section

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Section 27 00 00  
TECHNOLOGY  
(Filed Sub-Sub Bid Required)

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Section 27 00 00  
TECHNOLOGY  
(Filed Sub-Sub-Bid Required)

**PART 1 - GENERAL**

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.
- B. FILED SUB-SUB-BID REQUIRING A PARAGRAPH "E" LISTING on the FORM FOR SUB-BID required per M.G.L. Chapter 149 Section 44A to 44L, as amended to date. The Electrical Subcontractor will be responsible for all related building preparation and coordination, see specification for additional Paragraph "E" Listing requirements of the Listed Systems Contractor, and coordination of responsibilities.
- C. Section 27 00 00 TECHNOLOGY shall be a Filed Sub-Sub Bid of Section 26 00 10 ELECTRICAL WORK, requiring a Paragraph "E" Listing on the FORM FOR SUB-BID.
- D. This section shall be provided by a qualified Telecommunications Sub-Contractor.
  - 1. The Telecommunications Sub-Contractor shall be DCAM Certified by the state of Massachusetts Division of Capital Asset Management, in the category of: TELECOMMUNICATIONS SYSTEMS.

1.2 RELATED DOCUMENTS

- A. All of the Contract Documents, including Drawings, General and Supplementary Conditions and Division 01 - General Requirements, apply to the Work of this Section.
- B. Carefully examine all of the Contract Documents for requirements which affect the Work of this Section. The exact scope of Work of this Section cannot be determined without a thorough review of all specification Sections and other Contract Documents.
- C. Refer to Section 012300, Alternates, for alternates which may affect the work of this Section.

1.3 QUALITY ASSURANCE

- A. Sustainable Goals: The Architect has designed the project to meet the Owner's sustainable goals. Products and systems have been specified which meet certain third-party evaluations or have particular VOC and source requirements. Evaluation of products proposed for substitution will be evaluated based on the Owner's sustainable goals and other criteria included in Division 01. The Sub-Contractor is encouraged to use sustainable construction practices, means and methods. Unless specifically stated in a specification section, no sustainable design documentation is required of the Telecommunications Sub-Contractor.

#### 1.4 COOPERATION AND COORDINATION WITH OTHER TRADES

- A. The work shall be so performed that the progress of the entire building construction, including all other trades, shall not be delayed and not interfered with. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as directed.
- B. This Section shall be furnish/installed as follows by a single firm/company that is a qualified Telecommunications Sub-Contractor. The Electrical Sub-Contractor shall be responsible for properly preparing the project for installation by Telecommunications Sub-Contractor, as specified.
  - 1. Electrical Sub-Contractor responsibilities shall include: The Electrical Sub-Contractor shall be responsible for furnishing and installing all related building preparation including, but not limited to: outlet boxes with plaster rings, floor boxes, poke through devices, pathways, power, cableways, cable tray, cable protection, wiremold, surface raceways, cable supports, J hooks, conduits with bushings, sleeves with bushings (all conduits, stubs, sleeves, etc. shall be brought to an accessible ceiling or accessible area below floor), pull strings, bonding, grounding, core drilling, cutting, patching, fireproofing of penetration & openings, environmental seals, smoke and fire stopping seals including all conduits, raceways, sleeves, slots etc. where cables pass from one location to another, seismic supports, supplementary steel and channels, etc., for a completely operational system, as specified. The Electrical Sub-Contractor shall also accept delivery and properly store & secure all equipment and materials required by the Telecommunications Sub-Contractor. The Electrical Sub-Contractor shall install all specialized backboxes and any exterior antennas furnished by Telecommunications Sub-Contractor.
    - a. The Electrical Sub-Contractor shall provide cable tray over each rack and cabinet as required to facilitate a neat and orderly installation of cables and to secure the top of the racks to the structure. Cables shall drop straight down to equipment racks. Cable trays shall be secured at both ends to the structure and connected together as required for a complete contiguous installation. Utilize proper supports to support the cable tray to the building structure as well as the equipment rack and cabinet. Submit mounting supports for approval before installation.
    - b. This entire Section: The Electrical Sub-Contractor shall read this section in its entirety and shall provide all requirements of the Electrical Sub-Contractor as detailed in this Section.

2. Telecommunications Sub-Contractor responsibilities for this section shall be: Telecommunications Sub-Contractor shall be responsible for providing, installing, programming, troubleshooting, training and warranty service of all cabling, terminal equipment, headend equipment specified in this section for a completely operational system. The Telecommunications Sub-Contractor shall furnish all specialized backboxes (speaker, microphone, amplifier, etc.) and all exterior antennas to the Electrical Sub-Contractor for their installation.
  - a. Keep fully informed as to the shape, size and position of all openings required for all apparatus and give information in advance to build openings into the work. The Electrical Sub-Contractor shall furnish and set in place all sleeves, pockets, supports and incidentals.
  - b. All distribution systems which require pitch or slope such as plumbing drains, steam and condensate piping shall have the right of way over those which do not. Confer with other trades as to the location of pipes, ducts, lights and apparatus and install work to avoid interferences.
  - c. Coordinate exact locations and roughing in dimensions of all work before installation and make all final connections as required. Any changes required to avoid interferences or to provide adequate clearances for Code and maintenance requirements shall be made at no additional costs.
  - d. Structural elements of the project shall not be relocated, altered or changed to accommodate the work without written authorization from the Architect.
  - e. Work that is installed before coordination with other trades or that causes interference with the work of other trades shall be changed to correct condition.
  - f. Obtain a complete set of Project Drawings and Specifications for coordination and to determine the full scope of work.
  - g. Attend project coordination meetings to coordinate work of this Section, work of other trades and project and phasing requirements.

#### 1.5 SUBMITTALS

- A. Product Data for all materials specified and shown on drawings to be installed.
- B. Equipment List: Provide a detailed Equipment List showing quantities by manufacturer and model number of all major items of equipment and installation material to be used in the system as specified herein.
- C. Submit supporting hardware for this system as part of the work for approval prior to installation.
- D. Product Data: Include complete sets of indexed cut sheets, in quantity as dictated by the project, of all major pieces of equipment and materials being supplied. Arrange these sheets in the order the equipment appears in the Specification. Clearly highlight information showing compliance with this and/or all applicable Specifications. In the event that the manufacturer or representatives' cut sheet contains more than one item, clearly indicate which items of the cut sheet are intended for installation.

- E. Shop Drawings: Submit a set of complete Shop Drawings, by system, showing equipment to be installed. Include system configuration block diagrams of all equipment, indicating equipment type and model numbers. Show each and every component, system and subsystem, as well as all proposed connections between system components, and proposed layouts of equipment racks for the entire system.
  - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
  - 2. Cabling administration drawings and printouts.
  - 3. Wiring diagrams to show typical wiring schematics including the cross-connects.
  - 4. Cross-connects. Detail mounting assemblies and show elevations and physical relationship between the installed components.
  - 5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
  - 6. Cable tray layout showing cable tray route to scale with relationship between the tray and adjacent structural, electrical and mechanical elements.
- F. Quality Assurance Submittals:
  - 1. Provide manufacturer's certification that Installer is qualified to install systems specified.
  - 2. Provide names, qualifications, and certifications of installation personnel including Communication Systems Installer's site Supervisor/Foreman who shall be in charge of, and responsible for, all activities at the job site for the duration of the Project. The job Supervisor/Foreman shall not be changed during the project without notification and approval from the Owner.
  - 3. Complete warranty information including sample Registration Certificate.
  - 4. Technical Diagrams and Drawings:
    - a. Simplified single line block diagrams showing the interconnection of all equipment and functional relationships. Show all equipment, patch panels, cables and jacks, whether connected or not. The intent of these diagrams is to provide sufficient clear and complete information that a technician of average skill may efficiently troubleshoot and service the system, even if unfamiliar with the installation.
    - b. Provide "As Built" architectural quality plan Drawings at 1/8 in. = 1 ft.-0 in. scale. Provide an electronic copy of the "As Built" drawings on CD(s). As-Built Drawings shall include all device addresses.
    - c. All technical diagrams and drawings shall be mounted on the wall behind a clear plastic cover for protection. There shall be 1 set of the above drawings and diagrams provided per equipment room, this includes both the MDF Room and all IDFs.

## 1.6 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Refer to Division 01 – General Requirements.

## 1.7 TELEPHONE/DATA SYSTEM

### A. General:

1. All telecommunication and data system interconnecting wiring, terminal blocks, connections, terminations, shall be furnished and installed by a licensed and certified installer.
2. The Electrical Sub-Contractor (E.C.) shall furnish and install all raceways, and outlet boxes as indicated on the drawings, including pull wires for all empty raceways and all access panels. General Contractor will furnish and install all backboards (3/4 in. thick by 78 in. high) which shall be mounted at the MDF room and each IDF room.
3. General Requirements:
  - a. Applicable Standards:
    - 1) Materials and equipment shall be installed in accordance with the most current versions of the National Electrical Code, local codes, safety codes, ANSI, ASTM, EIA, TIA, BISCI, IEEE, UL, NFPA.
  - b. The following industry standards are the basis for the structured cabling system described in this document.

- ANSI/TIA/EIA
- TIA/EIA-568-B      Commercial Building  
Telecommunications Cabling  
Standard
- TIA/EIA-568-B.1      General Requirements
- TIA/EIA-568-B.2      Balanced Twisted Pair Cabling  
Components Standard
- TIA/EIA-568-B.3      Optical Fiber Cabling  
Components Standard
- TIA/EIA - 942      Telecommunications  
Infrastructure for Data Centers
- TIA/EIA-569-A      Commercial Building Standard  
for Telecommunications  
Pathway and Spaces
- TIA/EIA-606-A      Administration Standard for the  
Telecommunications  
Infrastructure of Commercial  
Buildings
- J-STD-607-A      Commercial Building  
Grounding/Bonding  
Requirements NFPA

- NFPA 70 National Electric Code (NEC)  
ISO/IEC
  - ISO 11801 Generic Cabling for Customer  
Premises
  - EIA/TIA-TSB 67. Telecommunications Systems  
Bulletin, Additional  
Transmission Specifications for  
Unshielded Twisted-Pair  
Cabling Systems"
  - EIA/TIA-455-61. "FOTP-61, Measurement of  
Fiber or Cable Attenuation  
Using an OTDR".
  - IEEE 802.3 "Carrier Sense Multiple Access  
with Collision Detection".
  - ATM Forum Standard for 155 Mb/s ATM over Category  
6 (AF-PHY-0015.000, 9/94)
  - BISI: Telecommunications  
Distribution Methods and LAN  
Design Manual
  - IEEE-802: Standards for Local Area  
Networking
  - UL Performance Levels  
Certification Program
  - ANSI-IEEE-C2: National Electrical Safety Code  
(NEC)
  - ANSI/NFPA-101: Life Safety Code
  - Massachusetts Electric Code CMR527
- c. Exposed wiring is not acceptable in any occupied space.
- d. Sub-Contractor is responsible for strict adherence to Massachusetts electrical codes, and all other applicable codes.
- e. The Sub-Contractor is responsible for obtaining municipal permits and inspections as mandated by law.
- f. All exposed cabling shall be run in raceway or conduit.
- g. All penetrations in station raceway shall have rubber or equivalent grommets to prevent cable cuts on trough edges.



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- h. Raceway shall be of sufficient size to accommodate all wiring. Fill density not to exceed 40 percent, unless otherwise noted. It is the responsibility of the bidder to determine the size needed based upon the floor plans provided. A minimum size of 1 in. conduit shall be adhered to, U.N.O or approval by the engineer.
  - i. All raceways shall be attached to the building structure using screws and anchors.
  - j. The I.T. Sub-Contractor is responsible for all aspects of MDF & IDF construction. Refer to drawings for configuration of each IDF and MDF.
  - k. All cabling at the MDF and IDFs shall be neatly bundled and dressed to the termination blocks. All appropriate cable management materials (slotted duct, D rings, etc.) should be utilized for this purpose. All wiring at IDF cabinets shall be installed concealed.
  - l. All labeling of cables shall be 6 in. back from the termination with machine generated labels, hand written labels are not permitted.
  - m. All cable pulls in conduit, raceway, innerduct, etc. shall have pull string left in place for future use.
  - n. Color code identification of cables must be maintained throughout all splices.
  - o. All station cabling shall be clearly and legibly labeled at both the faceplate end and the IDF/MDF termination blocks. In addition to labeling both the inside of the faceplates and IDF/MDF termination blocks, the cable jacket shall be labeled six inches back from the terminations on both ends. Labeling shall be machine generated.
  - p. Labeling of the outside of the jack with identification numbers shall be made using a Panduit LS8 handheld label machine or equal. Samples shall be provided to Engineer for approval prior to installation, the labeling scheme shall be submitted for review and approval, coordinate with the Schools IT Department prior to submitting.
  - q. In order to qualify for installation of the data communications system, Sub-Contractor must possess the required license classification, a performance history, experience in the installation and termination of optical fiber cable systems, and proof of time in business. Sub-Contractor must be trained and certified for the communications cable and hardware which it installs, and must furnish proof of certification.
  - r. License Classification: Sub-Contractor must possess a valid state Sub-Contractor's License.
- B. Unless otherwise indicated, the following work is not included as part of the systems integrator's responsibilities in this SECTION, except for coordination, and is to be performed by others as indicated:
- 1. Raceway shall be provided by the Electrical Sub-Contractor.
  - 2. Empty conduits to accessible point above ceiling or below floor shall be provided by the Electrical Sub-Contractor.
  - 3. Floor boxes and poke through devices shall be provided by the Electrical Sub-Contractor.

4. Standard device boxes with plaster rings for data and Integrated Instructional Technology Network System shall be provided by the Electrical Sub-Contractor.
5. Clock system backboxes and specialty pigtail connectors shall be installed by the Electrical Sub-Contractor and provided by this systems integrator. 120V wiring by Electrical Sub-Contractor.
6. Speaker/paging system backboxes shall be installed by the Electrical Sub-Contractor and provided by this systems integrator.
7. Structural blocking to support wall and ceiling mounted televisions/monitors shall be provided by the Construction Manager.
8. Interface with public utilities telephone service shall be arranged by the owner, and coordinated with this systems integrator.
9. Telephone equipment and handsets will be provided under a separate contract.
10. DEFINITIONS

- C. Main Cross Connect (MC): The MC is the location, within a building or complex of buildings, where the entire telecommunications system originates. It may include: the physical location, enclosure, wire and cable management hardware, termination hardware, distribution hardware, and patching and equipment racks.
- D. Horizontal Cross Connect (HC): The HC is the location in a building where a transition between the backbone or vertical riser system and the horizontal distribution system occurs.

#### 1.8 SYSTEM DESCRIPTION

- A. The data communications system shall consist of four components, active switch equipment, an optical fiber backbone, a copper twisted-pair backbone, and twisted pair copper work station cabling.

#### 1.9 SCOPE OF WORK

- A. The work under this Section includes providing of all material, labor, equipment and supplies and the performance of all operations to provide a complete working Integrated Instructional Technology Network System as required by the Drawings and details and as specified herein. Where the Drawings, Specifications, Codes, Regulations, Laws, or the requirements of the local Authority conflict, provide the higher quality and higher quantity indicated or required and follow the strictest requirement. In general, the work includes, but is not limited to, the following:
  1. Cabling for Sound and Clock per manufacturers requirements.
  2. Equipment Racks and Cabinets.
  3. Protection of new and existing work.
  4. Record Drawings and Documentation.
  5. Operation and Maintenance Instructions and Manuals for the Section's work.
  6. Nameplates, Labels and Tags.
  7. Testing and certification.
  8. Sound, Public Address, Master Clock.

1.10 PROTECTION OF WORK AND PROPERTY

- A. Be responsible for the care and protection of all work included under this Section until it has been tested and accepted.
- B. Protect all equipment and materials from damage from all causes including theft. All materials and equipment damaged or stolen shall be replaced with equal material or equipment at the option of the Architect and Owner.
- C. Materials and equipment stored for this project shall be protected and maintained according to the manufacturer's recommendations and requirements and according to the applicable requirements of NFPA 70B.
- D. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen and make good any damage caused.
- E. Use caution to avoid damage to existing work, and to prevent harm to personnel working in all areas.
- F. Observe all safety precautions and requirements for the construction.
- G. When open-flame or spark producing tools such as blower torches, welding equipment, etc., are required in the process of executing the work, the General Contractor shall be notified not less than twenty-four hours in advance of the time that the work is to begin and the location where the work is to be performed. Provide, where necessary, fire protective covering and maintain a constant non-working fire watch where work is being performed and until it is completed.
- H. The General Contractor and the Installer are responsible for initiating, maintaining, and supervising all safety precautions and requirements during construction.

1.11 SEQUENCING AND SCHEDULING

- A. Coordinate the work of this Section with the respective trades responsible for installing interface work, and ensure that the work performed hereunder is acceptable to such trades for the installation of their work.
- B. Continuity of all services shall be maintained in all areas which will be occupied or temporarily relocated during the construction period. If an interruption of service becomes necessary, such shall be scheduled in advance, made only upon consent of the Owner and at a time outside normal working hours as the Owner shall designate.
- C. Refer to the overall scheduling of the work of the project. Schedule work, process Submittal and order materials and equipment to conform to this schedule and install work to not delay nor interfere with the progress of the project.

- D. Inform Architect immediately of any delays or potential delays. Furnish manufacturer's letter to verify order date, equipment delays, expected shipment date, order number, and potential remedies to speed up delivery. Any costs to speed up delivery shall be implemented at no cost to the project if the equipment or material was not ordered as soon as possible after Contract award or within the time frames indicated with the Submittal.
- E. Be aware of, and plan for, project scheduling and phasing. Provide for complete continuous operation of all systems. Coordinate scheduling and phasing with the Architect, Owner, other Trades, and the General Contractor.

#### 1.12 WARRANTY

- A. Voice and Data Cabling Warranty: The products that shall best support the needs of the project and provide the highest level of system performance over the life of the facility, shall be a voice and data cabling system that is made up of system components designed, manufactured and installed as a total system solution. This requirement also applies to data patch cords specified in this Section; e.g. Ortronics patch cords shall be used with Ortronics jacks and patch panels.
- B. Provide a Manufacturer's Extended Product Warranty that covers product defects for all passive components of the Voice and Data Cabling System. Passive components are defined as those exhibiting no gain or contributing no energy to the Data Cabling System and include but are not limited to cabling, connectors, outlets, patch panels, patch cords, racks as outlined in PART 2 of this Specification.
  - 1. The following shall be covered by the Manufacturer's Extended Product Warranty:
    - a. All passive components that comprise the Voice and Data Cabling System will be free from manufacturing defects in material of workmanship under normal and proper use.
    - b. All passive components that comprise the Voice and Data Cabling System shall exceed the specifications of ANSI/TIA/EIA 568B series, and exceed ISO/IEC 11801 standards, including all subsequent changes to these standards that are in effect at the time of bidding, and shall meet or exceed the performance specifications as outlined in PART 2 of this Specification.
    - c. The installation shall exceed the insertion and return loss, attenuation and near end crosstalk (NEXT) requirements of ANSI/TIA/EIA 568B series and the ISO/IEC 11801 standards for cabling links/channel configurations specified in these standards including all subsequent changes to these standards that are in effect at the time of bidding.
    - d. Each Voice and Data Channel shall be capable of delivering data at 1.2 Gbps between active network electronics. A Data Channel is comprised of all passive components including cabling, connectors, patch panel port, and patch cords, with up to a total of 4 connections between Owner's network electronics (not in the contract).

2. Upon successful completion of the Voice and Data Cabling System installation by the Communication Systems Installer, and subsequent inspection by an authorized representative of the Manufacturer of the passive components, the Owner shall be provided with Registration Certificate, from the Manufacturer, registering the Installation.
3. Duration of Warranty: The warranty shall run for 20 years from the Date of Substantial Completion of the Project.
4. The Extended Product Warranty is applicable to the Voice and Data Cabling System passive components at the original site of installation. Under the Extended Product Warranty, the Manufacturer of the passive components shall either repair or replace the defective product(s) at the Manufacturers cost. This includes the replacement or repair cost of defective materials and the cost of labor to repair or replace any and all defective products.
5. The Communication Systems Installer shall provide a Manufacturer's warranty that the Voice and Data Cabling System shall be free from defects which prevent operation of the specific applications for which the original Voice and Data Cabling System was designed to support, including but not limited to: 10Base-T; 100Base-T; 52/155 Mbps ATM; 622Mbps 64-CAP ATM; 1000Base-T Gigabit Ethernet.

#### 1.13 MAINTENANCE

- A. Provide installers maintenance contract quote, upon request, for a period equal to warranty.
- B. Upon receipt of notice from the Owner of failure of any part of the systems during the warranty period, the affected parts shall be replaced. Any equipment requiring excessive service consisting of more than two unscheduled service calls, shall be considered defective and shall be replaced.
- C. Response times to warranty issues shall differ according to the level of the problem.
  1. A problem is considered to be corrected when the system and its components operate according to specified requirements.
  2. Warranty work shall be performed according to the procedures of the Owner, its staff and tenants and their normal operations.

#### 1.14 SEISMIC REQUIREMENTS

- A. Equipment and work shall meet the restraint requirements per the Massachusetts Building Code.

#### 1.15 FUNCTION AND OPERATION

- A. The intended function of the data communications cable system is to transmit data signals from a central location to several individual data outlet locations. Upon completion of the work outlined in this specification, the system shall be capable of transmitting data signals at a rate of 1000 Mbps.

- B. The multimode optical fiber cable system shall be capable of transmitting signals with a minimum bandwidth of 500 MHz at both 850 or 1300 nm. The cumulative signal loss, through connectors, jumpers, couplers, and fiber cable, shall be less than 10 dB. The singlemode optical fiber cable system shall be capable of transmitting signals with a bandwidth of up to 500 MHz at both 1300 and 1550 nm. The cumulative signal loss, through connectors, jumpers, couplers, and fiber cable, shall be less than 10 dB.
- C. Work station cable, from the HC to the work area, shall be installed in accordance with EIA/TIA-568-A specified installation practices, EIA/TIA TSB 67 recommended installation practices, manufacturer specified installation practices, and shall be capable of transmitting a signal at 1000 Mbps with acceptable attenuation and cross-talk measurements. The entire work station cable system, including wiring blocks, cable, and telecommunications outlets shall be tested for Category 6 compliance.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Throughout Part 2, material quantities are given. These quantities are given for reference purposes only. It is the responsibility of the Sub-Contractor to provide appropriate quantities of materials to provide a complete, functional system.
- B. Equipment shall be installed in accordance with Technology drawings. General installation provisions are as follows:
  - 1. Equipment Racks: Equipment racks shall be assembled and mounted in locations shown in the Drawings and as described herein. Each rack shall be assembled in accordance with the manufacturer's instructions and recommendations. Each rack shall be mounted such that the side rails are plumb. Each rack shall be affixed to the building structure at each of the mounting holes provided. Attachment shall be by 1/2 in X 1-1/4 in. lag bolts. A 3/8" pilot hole shall be drilled for each lag bolt. Each bolt shall be tightened to the extent that it holds the mounting hardware firmly, but not so tight as to distort the hardware or strip the threads. Equipment racks are to be co-located with the quadplex power outlets to allow for easy connection of racked equipment to the power system of the school.
  - 2. Wiring Blocks and Wire Management Components: Where required, wiring blocks and wire management components shall be mounted to the plywood backboard. Wiring blocks and wire management shall be mounted in accordance with the attached drawings. Each device shall be mounted such that its horizontal dimension is level. In cases where more than one device is mounted, they shall be aligned vertically. Each device shall be affixed to the plywood backboard by means of screws suitable for fastening to plywood. A minimum of four of the mounting holes provided shall be utilized for fastening. Screws shall be tightened to the extent that they hold the device snug to the backboard, but not so tight as to distort or damage the device. Wiring blocks shall be terminated in accordance with the manufacturer's instructions and recommendations. Installation of accessories shall also be conducted in accordance with the manufacturer's instructions and recommendations.

## 2.2 COMMUNICATION EQUIPMENT ROOM FITTINGS

### A. SUMMARY

Section Includes:

1. Telecommunications mounting elements.
2. Pathways
3. Telecommunications equipment racks and cabinets
4. Grounding.

### B. COORDINATION: Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
5. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

### C. PATHWAYS

1. General Requirements: Comply with TIA/EIA-569-A.
2. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
  - a. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
  - b. Support brackets with cable tie slots for fastening cable ties to brackets.
  - c. Lacing bars, spools, J-hooks, and D-rings.
  - d. Straps and other devices.

### D. EQUIPMENT FRAMES (RACKS)

1. Manufacturers:
  - a. APC
  - b. Cooper B-Line, Inc.
  - c. Hubbell Premise Wiring.
  - d. Panduit
  - e. Or equal

2. General Frame Requirements:
  - a. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
  - b. Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
  - c. Finish: Manufacturer's standard, baked-polyester powder coat.
3. Floor-Mounted Racks: Modular-type, four-post quick rail, aluminum construction.
  - a. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
  - b. Baked-polyester powder coat finish.
4. Equipment Cabinets:
  - a. 42RU, 24 in. W x 42 in. D.
  - b. Steel construction.
  - c. Treated to resist corrosion.
  - d. Perforated front and rear doors.
  - e. Lockable front and rear doors.
  - f. Louvered side panels.
  - g. Cable access provisions top and bottom.
  - h. Grounding lug.
  - i. Rack-mounted, 250-cfm fan.
  - j. 19 in. Dual slide rack mount monitor keyboard drawer (provide two)
  - k. Power strip provide two.
  - l. All cabinets keyed alike.
  - m. Regulatory approvals: EIA-310-D
  - n. Warranty: 5-years
  - o. Standards: UL 60950
5. Cable Management for Equipment Frames:
  - a. Metal, with integral wire retaining fingers.
  - b. Baked-polyester powder coat finish.
  - c. Vertical cable management panels shall have front and rear channels, with covers.
  - d. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.
6. Power Strips: Comply with UL 1363.
  - a. Rack mounting.
  - b. Receptacles: Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles for each power strip. Provide three in each rack.
  - c. LED indicator lights for power and protection status.
  - d. LED indicator lights for reverse polarity and open outlet ground.



- e. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
- f. Cord connected with 15-foot line cord.
- g. Rocker-type on-off switch, illuminated when in on position.
- h. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
- i. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.

E. GROUNDING

- 1. Comply with requirements in 260000 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.
- 2. Telecommunications Main Bus Bar:
  - a. Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
  - b. Ground Bus Bar: Copper, minimum 1/4-inch-thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
  - c. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
  - d. Comply with ANSI-J-STD-607-A.

F. LABELING

- 1. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.3 FIBER OPTIC CABLE:

- A. Fiber: The following cable specifications shall also be met by the cable manufacturer for fiber optic cable:

- 1. Multimode Optical Fiber Cabling: Multimode optical fiber cables shall be laser-optimized 50/125µm capable of supporting 10G/S data rates for distances up to 300 meters. Multimode optical fiber cables shall meet all of the requirements delineated within the specifications of ANSI/TIA/EIA-568-B1, B2, B3 and ISO/IEC 11801, 50/125 fiber shall be as noted in Table 1 and 2.

Table 1 Minimum Performance Parameters for LightSystem™ Cables Containing laser optimized 50/125 Multimode Fiber						
Fiber	Maximum Attenuation (dB/km)		Minimum Bandwidth (MHz-km)		Guaranteed Transmission Distance (m)	
	@ 850 nm	@ 1300 nm	@ 850 nm	@ 1300 nm	@ 850 nm	@ 1300 nm
Laser Optimized 50/125µm	3.5	1.0	1500	500	300	550

2. Singlemode Optical Fiber Cable:
  - a. Singlemode mode LightSystem™ fiber cables shall meet all of the requirements delineated within the specifications as listed in section 1 except that the attenuation and zero dispersion limits shall be as noted in Table 3 and 4.

TABLE 3 Minimum Performance Parameters for LightSystem™ Cables Containing Singlemode Fiber					
Fiber	Cable Type	Maximum Attenuation (dB/km)		Zero Dispersion	
		@ 1310 nm	@ 1550 nm	Wavelength (nm)	Slope (nm <sup>2</sup> -km)
Singlemode	Inside Plant	1.0	1.0	1300-1324	< 0.093
	Outside Plant	0.5	0.5		

TABLE 4 Minimum Performance Parameters for LightSystem Plus™ Cables Containing Singlemode Fiber					
Fiber	Cable Type	Maximum Attenuation (dB/km)		Zero Dispersion	
		@ 1310 nm	@ 1550 nm	Wavelength (nm)	Slope (nm <sup>2</sup> -km)
Singlemode	Inside Plant	0.5	0.5	1300-1320	< 0.092
	Outside Plant	0.4	0.3		

3. Attenuation:
  - a. The LightSystem™ cable as noted in Tables 1 and 3 and LightSystem Plus™ as noted in Tables 4 cable shall perform in accordance with the attenuation limits when tested per ANSI/EIA/TIA-455-46, -53, -61 or -78 (as applicable).
4. Bandwidth:
  - a. LightSystem™ as noted in Table 1 cable and LightSystem Plus™ cable as noted in Table 2 shall perform in accordance with the bandwidth limits when tested per ANSI/EIA/TIA-455-51 or ISO/IEC 793-1-C2A
5. Transmission distance:
  - a. The protocol pertinent to the transmission distance noted in Table 2 for LightSystem Plus™ cable is 10 Gigabit Ethernet per IEEE 802.3z.
6. Zero Dispersion Wavelength and Slope:
  - a. LightSystem™ cable shall perform as noted in Table 3 and LightSystem Plus™ cable as noted in Table 4 in accordance with the Zero Dispersion wavelength and slope limits when tested per ANSI/EIA/TIA-455-168, -169, or -175 (as applicable).
7. Fiber Laser Optimized 50/125 μm Multimode Optical fiber cables shall be manufactured by one of the following:
  - a. Berk-Tek
  - b. Commscope

- c. General Cable
  - d. Mohawk
  - e. Optical Cable Corporation
  - f. Or equal
  - g. Be a minimum of twelve strands of Laser Optimized 50/125  $\mu\text{m}$  multimode optical fiber for horizontal cabling.
  - h. Be appropriate for the environment in which it is installed.
8. Fiber equipment cords shall:
- a. Be available in standard lengths of 1, 3, and 5 meters, custom lengths shall also be available, and shall meet or exceed standards as defined in ANSI/TIA/EIA-568-A and ISO/IEC 11801.
  - b. Utilize duplex fiber cable that is 50/125 micron multimode, OFNR riser grade, and meets the requirements of UL 1666.
  - c. Utilize cable where the attenuation shall not exceed 3.5 dB/km @ 850 nm wavelength or 1.0 dB/km @ 1300 nm.
  - d. Have a cable jacket color for Laser Optimized 50/125 in aqua.
  - e. The connectors shall be SC or ST in accordance with TIA/EIA-568-A and must include a ceramic ferrule.
  - f. Have ST connectors with a metal coupling nut.
  - g. Have a minimum return loss of 20 dB (25 dB typical) at both 850 nm & 1300 nm.
  - h. Be made by an ISO 9001 and 14001 Certified Manufacturer.
  - i. Be UL 1666 approved.
  - j. Siemon Company FJ Series Fiber Jumpers Recommended Category 6.
9. Coordinate fiber patch cords with Owner prior to release. Provide SC to LC, ST to LC, or any combination of the two. Provide one per fiber port.
10. Warning Tags: At each location where the fiber cable is exposed to human intrusion, it shall be marked with warning tags. These tags shall be yellow or orange in color, and shall contain the warning: "CAUTION FIBER OPTIC CABLE". The text shall be permanent, black, block characters, and at least 3/16" high. A warning tag shall be permanently affixed to each exposed cable or bundle of cables, at intervals of not more than five (5) feet. Any section of exposed cable which is less than five (5) feet in length shall have at least one warning tag affixed to it.
11. T-Bar Suspended Ceilings: Copper station cabling may be run outside of conduits and above T-Bar suspended ceilings when available, at the option of the installer. Cables installed in this fashion are to be run horizontally in bundles and tied down neatly, well clear of any light fixtures or other electrical appliances that may affect data transmissions.

- B. Optical fiber Interconnect Equipment: Interconnect equipment may be mounted either on the plywood backboard or in the equipment racks, depending on the particular application. When mounted on the backboard, the horizontal dimension shall be level. A minimum of four of the mounting holes provided shall be utilized for fastening. Screws shall be tightened to the extent that they hold the device snug to the backboard, but not so tight as to distort or damage the device. Interconnect equipment mounted in racks shall be affixed to the rack by at least four screws. The screws shall be of the correct size and thread configuration for the holes in the rack. They shall be tightened to the extent that they hold the equipment firmly to the rack, without distorting the equipment or stripping the threads.
- C. All optical fiber interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations. All large openings into wall mounted cabinets shall be covered by a grommet.

#### 2.4 UTP CABLE (BACKBONE)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Belden CDT Inc.; Electronics Division.
  - 2. CommScope
  - 3. Mohawk; a division of Belden CDT.
  - 4. Molex
  - 5. Superior Essex Inc.
  - 6. Or equal
- B. Description: Multi-pair Backbone Cable: Category 5e, 100-ohm, 25-pair UTP binder groups covered with a gray thermoplastic jacket.
  - 1. Comply with ICEA S-90-661 for mechanical properties.
  - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
  - 3. Comply with TIA/EIA-568-B.2, Category 5e.
  - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications: Type CMP, complying with NFPA 262.
- C. Multi-pair backbone cables: Provide copper backbone cable that meets or exceeds the following specifications:
  - 1. Electrical Specifications:

Maximum DC Resistance	28.6 $\Omega$ /1,000 ft (9.4 $\Omega$ /100m)
Maximum DC Resistance Unbalanced	5 percent
Maximum Capacitance Unbalanced (pair to ground)	1,000 pF/1000 ft. (328 pF/m)
Mutual Capacitance @ 1kHz	18 nF/1000 ft (5.9 nF/100 m), max.

2. Attenuation (dB/100 m [328 ft.]):

Frequency	Attenuation (Max.)
1.00 MHz	2.3 dB
4.00 MHz	4.9 dB
10.00 MHz	8.5 dB
16.00 MHz	12 dB

3. Worst Pair Near-End Crosstalk (NEXT) dB/100 m [328 ft]:

Frequency	Pair-To-Pair NEXT (Max.)
1.0 MHz	13.8 dB
4.0 MHz	11.2 dB
10.0 MHz	10.2 dB
16.0 MHz	9.2 dB

2.5 FIBER INNERDUCT

- A. DESCRIPTION: From the MDF to each IDF, segments of optical fiber innerduct shall be installed.
- Quantities Required: Innerduct runs do not have to be continuous throughout, breaks are expected at the pull boxes. Sub-Contractor is responsible for determination of actual lengths of innerduct required. Enough innerduct shall be provided and installed to extend from the fiber service loop in the MDF to the fiber service loop in each IDF. If the route passes through a pull box, the segments of innerduct shall extend twelve inches into the pull box. If the route passes through an enroute HC, each segment of innerduct shall extend at least twelve inches beyond the end of the service conduit.
- B. INSTALLATION: Fiber innerduct shall be installed in accordance with manufacturer's instructions and industry standards. Within the equipment rooms, the innerduct shall extend from the end of conduit to four feet above the floor and shall be affixed to the backboard by means of clamps designed for that purpose. Care shall be taken to avoid kinking the innerduct or applying excessive tension during the installation process.

2.6 FIBER DISTRIBUTION

- A. DESCRIPTION: From the MDF to each IDF a continuous segment of fiber cable shall be provided.
- Product: 12 strands multi-mode 50/125 UM OM3 laser optimized and 6 strands single-mode 8.3/125 UM.
  - Quantities Required: The Sub-Contractor is responsible for determination of actual segment lengths. Actual quantities will be determined by the routing established by the electrical engineer.
  - Required Accessories and Quantities:
    - Kit of Parts: Sufficient quantities to block and buffer both ends of each cable segment.
    - Sealant: Sealant sufficient quantities to block each end of each cable segment.

- 
- B. INSTALLATION: Installation shall be conducted following guidelines established by the product manufacturer and industry standards.
1. Fiber Optic Cable: During installation of the optical fiber cable segments into the conduit system, special care shall be taken to avoid damage to the cable. While under pulling tension, the cable shall not be bent into a curve with a radius of less than 20 times the cable diameter. Pulling tension shall not exceed manufacturer's recommended maximum tensile load. Sub-Contractor shall utilize a winch with tension control or a "break-away" link designed to break away at or below the recommended maximum tension.
- C. The optical fiber cable shall be routed through the existing conduit and onto the appropriate HC backboard. Routing on the backboard shall be straight and plumb. A minimum ten foot service loop shall be provided at each terminal location. Refer to Drawings for cable configuration.

## 2.7 WORK STATION CABLE

- A. DESCRIPTION: From each MDF or IDF, 4-pair enhanced Category 6A cables shall be routed to each work station (data outlets). Category 6A shall be installed for wireless access node outlets per Technology Drawings.
1. Product:
    - a. Copper 4-pair UTP:
      - 1) UTP cables shall:
        - a) Be manufactured by one of the following:
          - Hitachi Cable Manchester
          - Hubbell Premise Wiring
          - Berk-Tek
          - Commscope
          - General Cable
          - Mohawk
          - Or equal
  2. Required Accessories and Quantities (Hard Wall Locations):
    - a. Work Station: shall be metal with ivory or white finish (refer to drawings), Single Gang, Single Port Face plate. Using Panduit CMB\*\*-X blank modules to fill unused ports. Refer to drawings for two, three, and four gang configurations. Modules shall be CJ688TP\*\* – color to be selected by engineer.
  3. Work Area Equipment Cords: The Work Area Equipment Cords shall meet or exceed the following criteria:  
Modular Equipment Cords: Category 6/6A cable
  4. Category 6A, modular equipment cords shall:
    - a. Be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color-coded twisted-pairs within a flame-retardant jacket.
    - b. Be equipped with modular 8-position (RJ45 style) plugs on both ends, wired straight-through with standards compliant wiring.

5. Use modular plugs which exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 micro-inches minimum of gold plating over nickel contacts.
  6. Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.
  7. Utilize cable that exhibit power sum NEXT performance.
    - a. Be available in several colors with or without color strain relief boots featuring a snagless design.
    - b. Provide one 10 foot cord per data jack shown on drawings.
    - c. Be made by an ISO 9001 and 14001 Certified Manufacturer.
    - d. Electrical Specifications:
    - e. DC resistance per lead:  $9.38 \Omega / 100 \text{ m}$  maximum.
    - f. Input impedance without averaging:  $100 \Omega + 15 \text{ percent}$  from 1 to 100 MHz.
    - g. 100 percent transmission tested with laboratory grade network analyzers for proper performance up to 1000 MHz. Vendor shall guarantee cords are compatible with category 6A links/3A links.
  8. UL VERIFIED (or equivalent) for TIA/EIA proposed category 6A electrical performance.
  9. UL LISTED 1863.
  10. All information outlets for  $100 \Omega$  22-26 AWG copper cable shall:
    - a. Be available in black, white, gray, ivory and light ivory.
    - b. Accommodate a minimum of two 8-position / 8-conductor modular jacks.
    - c. Utilize compliant pin technology 110 style insulation displacement connectors which allows the use of a 4-pair impact tool.
    - d. Allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit.
    - e. Be constructed of high impact, flame-retardant thermoplastic.
    - f. Be available in a screened version for  $100 \Omega$  ScTP cable.
    - g. Be made by an ISO 9001 and 14001 Certified Manufacturer.
    - h. Electrical Specifications:
    - i. ANSI/TIA/EIA-568-B1, B2, B3 and ISO/IEC 11801 proposed category 6A compliant.
- B. INSTALLATION: Installation shall be conducted in accordance with guidelines established the manufacturer and industry standards. Wall Plates shall be mounted such that their vertical dimension is plumb. Each wall plate shall be labeled with its respective work station number. Each modular mounting frame shall be labeled with its respective work station number.

## 2.8 MAIN DISTRIBUTION FACILITY (MDF)

- A. DESCRIPTION: The equipment shall be installed in accordance with Drawings.
1. Products and Quantities:
    - a. Equipment Rack: - As specified.

- 
- b. Fiber Interconnect: Panduit FRME24 rack mount fiber optic enclosure or equal. Supply and install as many as necessary to service all fiber strands entering the MDF.
  - c. Modular Patch Panels: Panduit angled patch panel or equal: 48-port patch panel wired Category 6A Patch Panel. One port for each workstation served from the MDF with a minimum of 12 spare ports are required. Provide CAT6A angled patch panel for wireless CAT6A ports. If the number of workstation cables, plus required spare count 12 is greater than 48, then a second 48-port patch panel is required. Supply and install as many patch panels in the MDF as necessary to service all workstation cables plus the required spare count. Provide separate CAT 6A patch panels for CAT 6A cables serving wireless access point outlets.
  - d. Patch Cables: Panduit UTPSPXX-\*\* or equal where XX is the length in feet and \*\* is the color. The length shall vary between 3 ft. and 25 ft. and shall be determined by the owner. Colors shall also be determined by the owner. A minimum of five different color patch cables shall be carried for different systems.
    - 1) Cable Color configuration:
      - a) - Orange - Wireless
      - b) - Green - Security/Card Access
      - c) - White - VoIP
      - d) - Blue - Data
      - e) - Yellow - BMS Connections
  - e. Data Port Labeling Standard
    - 1) <Closet>-<Patch Panel>-<Cable Purpose><Patch Panel Port Number> For Example: 3330-B-D43, This signifies that IDF Room 3330 Panel B on Data Patch Panel port 43
2. Required Accessories and Quantities:
    - a. Adapter Panels: Panduit FAP6WEIDSC – 6 Port Duplex Multimode SC Adapter Panels.
    - b. Fiber Jumpers: Panduit F6D3-3M3Y, 3 meter and 5 meter, Duplex, 50 micron OM3, SC to LC Fiber and ST to LC Fiber Jumper or equal.
    - c. Cable Management: Panduit WMPH2E Front/Rear cable manager or Panduit WMPLS Low Profile Cable Manager or equal.
    - d. Cable Management Rings and Strain Relief: Panduit WMBV1 21 in. x5 in. Vertical Manager Ring, Panduit WMBV2 2 in. x5 in. Vertical Manager Ring and/or Panduit WMSRC1 or WMSRC2 strain relief clips. Provide and install sufficient quantities to conform to the attached Drawings.
  3. Equal manufacturers:
    - a. Hubble
    - b. Ortronics
    - c. Commscope
    - d. Or equal



- B. INSTALLATION: Installation shall be conducted in accordance with manufacturer's recommendations, industry standards, and this specification. Installation includes complete assembly and mounting of the fiber interconnect equipment, dressing the fiber and copper cables, complete assembly and mounting of the equipment rack, and mounting of the wiring blocks. Equipment shall be mounted in accordance with attached Drawings.

## 2.9 INTERMEDIATE DISTRIBUTION FACILITIES

- A. DESCRIPTION: The equipment shall be installed in accordance with Drawings.

### 1. Products and Quantities:

- a. Equipment Rack: - As specified.
- b. Fiber Interconnect: Panduit FRME24 rack mount fiber optic enclosure or equal. Supply and install as many as necessary to service all fiber strands entering the IDF.
- c. Modular Patch Panels: Panduit CPPLA48WBLY or equal: 48-port patch panel wired Category 6A Patch Panel. One port for each workstation served from the IDF with a minimum of 12 spare ports are required. Provide CAT6A angled patch panel for wireless CAT6A ports. If the number of workstation cables, plus required spare count 12 is greater than 48, then a second 48-port patch panel is required. Supply and install as many patch panels in the IDF as necessary to service all workstation cables plus the required spare count. Provide separate CAT 6A patch panels for CAT 6A cables serving wireless access point outlets.
- d. Patch Cables: Panduit UTPSPXX-\*\* or equal where XX is the length in feet and \*\* is the color. The length shall vary between 3 ft. and 25 ft. and shall be determined by the owner. Colors shall also be determined by the owner. A minimum of five different color patch cables shall be carried for different systems.
  - 1) Cable Color configuration:
    - a) - Orange - Wireless
    - b) - Green - Security/Card Access
    - c) - White - VoIP
    - d) - Blue - Data
    - e) - Yellow - BMS Connections
- e. Data Port Labeling Standard
  - 1) <Closet>-<Patch Panel>-<Cable Purpose><Patch Panel Port Number> For Example: 3330-B-D43, This signifies that IDF Room 3330 Panel B on Data Patch Panel port 43

### 2. Required Accessories and Quantities:

- a. Adapter Panels: Panduit FAP6WEIDSC – 6 Port Duplex Multimode SC Adapter Panels.
- b. Fiber Jumpers: Panduit F6D3-3M3Y, 3 meter and 5 meter, Duplex, 50 micron OM3, SC to LC Fiber and ST to LC Fiber Jumper or equal.
- c. Cable Management: Panduit WMPH2E Front/Rear cable manager or Panduit WMPHS Low Profile Cable Manager or equal.

- d. Cable Management Rings and Strain Relief: Panduit WMBV1 21 in. x5 in. Vertical Manager Ring, Panduit WMBV2 2 in. x5 in. Vertical Manager Ring and/or Panduit WMSRC1 or WMSRC2 strain relief clips. Provide and install sufficient quantities to conform to the attached Drawings.
- 3. Equal manufacturers:
  - a. Hubble
  - b. Ortronics
  - c. Commscope
  - d. Or equal
- B. INSTALLATION: Installation shall be conducted in accordance with manufacturer's recommendations, industry standards, and this specification. Installation includes complete assembly and mounting of the fiber interconnect equipment, dressing the fiber and copper cables, complete assembly and mounting of the equipment rack, and mounting of the wiring blocks. Equipment shall be mounted in accordance with Drawings.

## 2.10 TESTING AND DOCUMENTATION

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
  - 2. Visually confirm Category 5e marking of outlets, cover plates, outlet/connectors, and patch panels.
  - 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 4. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
    - a. Provide test instruments that meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
  - 5. Multi-pair Voice Riser Tests:
    - a. Test each pair of multi-pair voice riser cables for proper polarity; no reversals; no transpositions; continuity; no shorts; no AC voltages; no DC voltages; no opens; and proper numbering at each termination.
    - b. Bring cables and/or pairs not meeting the requirements of the standard into full compliance, at no additional cost to the Owner.

- c. Document cable testing in accordance with Submittals Article. Provide a table of test results in a 3-ring binder submitted with the as-built Drawings.
  6. Category 6A Data, and Voice UTP Cable Testing:
    - a. Test voice and data jack in each Outlet for Category 6A ANSI/TIA/EIA 568B series compliance, using a Certified Level III testing instrument. Tests shall verify both the integrity of all conductors and correctness of the termination sequence. Tests shall also include length, mutual capacitance, characteristic impedance, attenuation and near-end and far-end crosstalk. Testing shall be performed between modular jacks at the Outlets and the modular jacks at the patch panel field.
    - b. The Communication Systems Installer shall bring cables and/or pairs not meeting the requirements of the standard into full compliance, at no additional cost to the Owner.
    - c. Document cable testing in accordance with Submittals Article. Provide a table of test results in a 3-ring binder submitted with the as-built Drawings.
  7. Fiber Optic Cable Testing:
    - a. Test all fibers in the completed end-to-end system. Testing shall consist of a bi-directional end to end OTDR trace, or a bi-directional end to end power meter test performed per ANSI/TIA/EIA 455 53A. The system loss measurement shall be provided at 850 and 1310 nanometers.
    - b. Pre-installation cable testing: Test all fiber optic cable prior to the installation of the cable. Assume all liability for the replacement of the cable should it be found defective after the installation.
    - c. Loss Budget: Fiber links shall have a Maximum Loss of:
    - d.  $\text{Maximum Loss} = (\text{allowable loss per km}) (\text{km of fiber in link}) + (.4\text{dB})(\text{number of connectors})$  Note: A mated connector-to-connector interface is defined as a Single connector.
    - e. Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two. Any link not meeting the requirements of the Maximum Loss shall be brought into compliance at no additional charge to the Owner.
    - f. Prepare a certification report listing the test results and both the calculated and measure loss for each fiber. Submit this report with the test results as called for in the Submittals Article.
    - g. Bring cables and/or strands not meeting the requirements of the standard into full compliance.
    - h. Test data shall reference wing and room number locations.
- D. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
  1. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

- E. Document data for each measurement. Print data for submittals in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- F. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- H. Prepare test and inspection reports.

## 2.11 INTEGRATED SOUND, PUBLIC ADDRESS SYSTEM

### A. DEFINITIONS

- 1. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
- 2. VU: Volume unit.
- 3. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

### B. PERFORMANCE REQUIREMENTS

- 1. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- 2. Seismic Performance: Provide supports and seismic restraints for control consoles, equipment cabinets and racks, and components that withstand the effects of earthquake motions determined according to SEI/ASCE 7.
  - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

### C. SUBMITTALS

- 1. Product Data: For each type of product indicated.
- 2. Shop Drawings: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.
  - a. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
  - b. Console layouts.
  - c. Control panels.
  - d. Rack arrangements.

- e. Calculations: For sizing backup battery.
- f. Wiring Diagrams: For power, signal, and control wiring.
  - 1) Identify terminals to facilitate installation, operation, and maintenance.
  - 2) Single-line diagram showing interconnection of components.
  - 3) Cabling diagram showing cable routing.
- 3. Delegated-Design Submittal: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - a. Detail fabrication and assembly of supports and seismic restraints for control consoles, equipment cabinets and racks, and components.
- 4. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
- 5. Qualification Data: For qualified Installer and testing agency.
- 6. Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, accessories, and components, from manufacturer.
  - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- 7. Field quality-control reports.
- 8. Operation and Maintenance Data: For public address and mass notification systems to include in emergency, operation, and maintenance manuals.

#### D. QUALITY ASSURANCE

- 1. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.
  - a. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.
- 2. Source Limitations: Obtain public address and mass notification systems from single source from single manufacturer.
- 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 4. Comply with NFPA 70.

E. COORDINATION

1. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

F. MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Rauland is Basis of Design.
  - a. Rauland
  - b. Bogen Communications, Inc.
  - c. Simplex Grinnell
  - d. Or equal.

G. FUNCTIONAL DESCRIPTION OF SYSTEM

1. System Functions: Provide the following system functions, components and capabilities:
  - a. 25 Volt paging system providing paging zones as indicated and determined by the Owner.
  - b. Provide 2-way talkback capability within every classroom and within every office. These areas shall be grouped into various paging zones as defined by the school and via the software provided with the system. The intercom paging system shall be interfaced to the owner furnished telephone system via 4 available trunk ports. Programmable buttons on the admin phones shall permit various zone paging. Coordination between the intercom system integrator and the phone system supplier shall result in this effort. The intercom system provider shall also furnish a VoiP converter to act as an interface between the phone system and the intercom paging system.
  - c. A system comprised of all solid state electronics, utilizing a microprocessor based central processor unit, power supplies, audio interface cards, control cards, input/output cards, telephone interface cards, transformers, paging amplifiers, and associated components as required for a complete system.
  - d. Modular design utilizing plug-in circuit cards to enable quick on-site replacement or addition of components for system expansion and modification.
  - e. Connect station wiring to the system using insulation displacement connectors to allow quick disconnection of field cables from the System terminal boards.

- f. Storage of user programmable data in a non-volatile EEPROM memory to prevent memory loss during a power failure. Provide a system time clock that is capable of maintaining correct time for a period of 14 days in the event of a power failure. Return the system programming to the original factory default settings by keying a special code form the Console.
- g. User capability to change system programming for all paging functions, bell functions, and clock functions – both master and slave. Provide the owner with the required training, documentation, and software to accomplish these functions.
- h. Rack mount the Public Address main equipment including card cages and all cards, power amplifiers, program sources, and related components in the MDF. Provide remote system programming capability of Public Address and Master Clock features by an Administrative Control Console. Attending to the main equipment in the MDF for normal day-to-day operation of the system is not a necessary requirement. Systems requiring regular adjustment will be rejected.
- i. Include a tone generator from the master clock system so that all classroom tone changes are synchronized with the master clock system and all associated classroom clocks.
- j. User capability to selectively connect any zone to any available signal channel.
- k. User capability to selectively control sound from microphone outlets and other inputs.
- l. "All-call" feature that connects the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
- m. Telephone paging adapter capability to allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
- n. Administrative Control Console for facilitating all Public Address System announcements and programming, to include but not be limited to: Emergency all-call; paging zone and number assignments; call-in priority levels with tone characteristics; Master Clock event and tone signaling; monitor and reporting on call-in line faults; and manually distribute unique tones to all zones and speakers in the system.
- o. Cabling, appropriate adapters and connection to a local building digital VoIP System (by Owner), allowing any telephone handset that is part of the telephone system to page and conduct hands free open voice communication with any speaker in the system; the Control Console; or any other classroom telephone. Connection to the local phone system shall not diminish or restrict any of the capabilities of local telephone system. Public Address System interfaces shall allow any programmed telephone to perform but not be limited to the following intercommunication system functions: all-call, zone call, intercom call to classroom speakers, distribute class change signals.

- p. User programmable zone paging to all classroom and office speakers using microphone, Control Console or telephone. Public address zones shall be software programmable to include 2, 3, 4 digit numbers or a letter and a 3-digit number, or any combination. Zone paging shall be independent of time and program zones and shall provide easy access to groups of zones or all-zone pages.
- q. Distribution of general announcements over school loudspeakers using a microphone, Control Console, or telephone handset, on an All-Call basis, pre-selected zone basis, or multiple-zone basis to any of eight paging zones. Speaker assignments to any of eight zones shall be user-programmable from the Control Console.
- r. Distribution of emergency paging announcements over school loudspeakers using a microphone, Public Address Control Console, or telephone handset. Emergency announcements shall have the highest priority over other system functions.
- s. Ability to designate individual room station within the system as a fixed zone by the simple entering of a single keystroke at the Control Console during a page selection.
- t. Selection and monitoring of individual program sources (Microphone, AM/FM Tuner, or CD, MP3) and distribution by the Control Console.
- u. Control Console programming of administrative microphone for control and distribution of public announcements, to eliminate the need to go to the central electronics for microphone set up. Keying the microphone shall automatically mute all other audio programs at a lower priority in the system. A preset shall be provided to mute all local sound systems by contact closure allowing the Public Address system to override local sound system programs. Microphone shall transmit to all rooms or specific speakers' zones as programmed in the system software.
- v. The capability of multiple open voice intercom paths. Intercom paths shall be global.
- w. Automatic gain control of intercom speech to assure constant speech level.
- x. Automatic sounding of a warning tone over any loudspeaker selected for two-way communications to alert the classroom teacher to an incoming announcement.
- y. A minimum of four channels for intercom communications or audio program distribution.
- z. Emergency Calls that can be initiated from a single call key programmed at the classroom telephone.
- aa. The ability to monitor the school building either on or off the premises from a single telephone.



- bb. Audio program distribution to eight different areas of the building selected by the Control Console. Inputs shall be provided for 5 low impedance microphones, tuner, CD player and auxiliary source. Program material shall include audio programs from standard AM/FM tuner, CD player, or auxiliary source. Provide program source equipment including AM/FM tuner, CD player. Provide Control Console with the ability to monitor program sources being distributed. Provide an individual AM/FM Tuner rack mounted receiver. Provide a separate CD player with IPod docking station as a separate mounted piece of equipment in the rack.
- cc. Audio zones that are different than paging and time zones. Audio source equipment shall have the ability to be located remotely from the main system control electronics, and shall have the ability to distribute two channels of audio simultaneously if so desired. School shall be equipped with 1 rack mounted AM/FM tuner, 1 Rack Mounted CD player. Provide an outside FM roof mounted antenna.
- dd. RS232 Input/Output Interface, Personal Computer, Modem, and Printer for monitoring activity within System and for displaying and printing system management information. System shall perform diagnostics, or logging transactions either on or off premises.
- ee. Provide input from intrusion system such that if a panic alarm is activated, it shall sound an emergency warning broadcast throughout the school on all speakers. Power amplifiers that provide a minimum power capacity of 1 watts per cone speaker location and Door Signaling device plus 15 watts of power per horn type speaker locations.
- ff. In addition to programmable zones, provide the following additional zones:
  - 1) Corridors on their own zone
  - 2) Outside speakers on their own zone.
- gg. Cabling that is specified by the manufacture, which provides shielding of conductors so that the Public Address System does not interfere with the Telephone Systems and Telephone System cabling.
- hh. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
- ii. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.

#### H. GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

- 1. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- 2. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

3. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with TIA/EIA-310-D.
4. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

I. PREAMPLIFIERS

1. Preamplifier: Integral to power amplifier.
2. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.
3. Total Harmonic Distortion: Less than 1 percent.
4. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.
5. Input Jacks: Minimum of two. One matched for low-impedance microphone; the other matchable to cassette deck, CD player, or radio tuner signals without external adapters.
6. Minimum Noise Level: Minus 55 dB below rated output.
7. Controls: On-off, input levels, and master gain.

J. POWER AMPLIFIERS

1. Mounting: Console.
2. Output Power: 25-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.
3. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.
4. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
5. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.
6. Output Regulation: Less than 2 dB from full to no load.
7. Controls: On-off, input levels, and low-cut filter.
8. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

K. TRANSFER TO STANDBY AMPLIFIER

1. Monitoring Circuit and Sensing Relay: Detect reduction in output of power amplifier of 40 percent or more and, in such event, transfer load and signal automatically to standby amplifier.

L. MICROPHONES

1. Paging Microphone:
  - a. Type: Dynamic, with cardioid polar characteristic.
  - b. Impedance: 150 ohms.
  - c. Frequency Response: Uniform, 50 to 14,000 Hz.
  - d. Output Level: Minus 58 dB, minimum.
  - e. Finish: Satin chrome.
  - f. Cable: C25J.

- g. Mounting: Desk stand with integral-locking, press-to-talk switch.

M. VOLUME LIMITER/COMPRESSOR

- 1. Minimum Performance Requirements:
  - a. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.
  - b. Signal Reduction Ratio: At least a 10:1 and 5:1 selectable capability.
  - c. Distortion: 1 percent, maximum.
  - d. Rated Output: Minimum of plus 14 dB.
  - e. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
  - f. Rack mounting.

N. CONTROL CONSOLE

- 1. Cabinet: Modular; complying with TIA/EIA-310-D.
- 2. Housing: Steel, 0.0478 inch minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.
- 3. Panel for Equipment and Controls: Rack mounted.
- 4. Controls:
  - a. Switching devices to select signal sources for distribution channels.
  - b. Program selector switch to select source for each program channel.
  - c. Switching devices to select zones for paging.
  - d. All-call selector switch.
- 5. Indicators: A visual annunciation for each distribution channel to indicate source being used.
- 6. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.
- 7. Spare Positions: 20 percent spare zone control and annunciation positions on console.
- 8. Microphone jack.

O. EQUIPMENT CABINET

- 1. Comply with TIA/EIA-310-D.
- 2. House amplifiers and auxiliary equipment at each location.
- 3. Cabinet Housing:
  - a. Constructed of 0.0478-inch steel, minimum, with front- and rear-locking doors and standard TIA/EIA-310-D-compliant, 19-inch racks.
  - b. Arranged for floor or wall mounting as indicated.
  - c. Sized to house all equipment indicated, plus spare capacity.
  - d. Include 20 percent minimum spare capacity for future equipment in addition to space required for future cassette deck and CD player.

4. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.
5. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

P. EQUIPMENT RACK

1. Racks: 19 inches' standard, complying with TIA/EIA-310-D.
2. Power-Supply Connections: Compatible plugs and receptacles.
3. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
4. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
5. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with socket for 5-A cartridge fuse for rack equipment power.
6. Service Light: At top rear of rack with an adjacent control switch.
7. Vertical Plug Strip: Grounded receptacles, 12 inches o.c.; the full height of rack.
8. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.
9. Spare Capacity: 20 percent in rack for future equipment.

Q. TELEPHONE PAGING ADAPTER

1. Adapters shall accept voice signals from telephone station dialing access and automatically provide amplifier input and program override for preselected zones.
2. Minimum Frequency Response: Flat, 200 to 2500 Hz.
3. Impedance Matching: Adapter matches telephone line to public address equipment input.
4. Rack mounting.
5. Provide pre-recorded voice announcements based upon group dialed.

R. TONE GENERATOR

1. Generator shall provide clock and program interface with public address and mass notification system.
2. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.
3. Pitch Control: Chimes and tone.
4. Volume Control: All outputs.
5. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.
6. Mounting: Rack.

S. MONITOR PANEL

1. Monitor power amplifiers.
2. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.
3. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.
4. Mounting: Rack.

T. LOUDSPEAKERS

1. Cone-Type Loudspeakers:
  - a. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
  - b. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
  - c. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
  - d. Minimum Dispersion Angle: 100 degrees.
  - e. Rated Output Level: 10 W.
  - f. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
  - g. Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically damped. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting. Flush-Ceiling-Mounting Units: In steel back boxes, acoustically damped. Metal ceiling grille with white baked enamel is the standard for color. Refer to the floor plans and consult with the Architect for final approval of speaker grill colors in the Auditorium, Large Group Instruction Room, Gym, and other specialty spaces.
2. Exterior Loudspeakers:
  - a. The exterior loudspeaker shall be a Bogen Model A2T (70V) with a power handling capacity of 16W (70V), or approved equivalent, loudspeaker consisting of one 6-inch nominal low frequency transducer, one 1/2-inch nominal high frequency transducer mounted coaxially, with a filter network for dividing frequencies between the transducers. A weather-tight enclosure shall house all components. The enclosure shall be constructed from an injection molded, high density (30% or greater), mineral-filled polypropylene material compounded with UV inhibitors.
  - b. Two molded-in colors shall be made available (Black and White). Perforated speaker grilles shall be made from heavy-gauge PVC, color-matched to the enclosure.

- c. The low frequency driver shall utilize a metal-alloy cone with deep-anodized surface treatment for rigidity and corrosion resistance. The cone shall provide a heat transfer element for the voice coil under high power input. Compounded rubber cone surrounds shall be formulated to withstand all-environment installations, including salt spray, ultraviolet light (UV), heat, cold, and constant humidity. The voice coil will be centered via a high gauss, low viscosity magnetic fluid (ferrofluid), which increases the heat transfer rate from the voice coil under long-term, high-power use. The magnetic fluid shall prevent corrosion from occurring in the magnet gap
  - d. The high frequency driver shall utilize an environmentally stable polycarbonate diaphragm. Ferrofluid shall dampen the voice coil and assist in the heat transfer for higher power capability.
  - e. Environmental testing shall ensure long-term operation in any weather. Specifications shall meet or exceed Mil-Std-810E Test Methods for Temperature, Humidity, Ultraviolet Light, and Salt Spray.
  - f. The mounting bracket shall be designed with multiple angles to facilitate installation in corners or when angulation is required. An integral safety strap mounting point shall be included. The loudspeaker shall rotate, on its axis, a minimum of 180 deg. The bracket shall be formed from heavy-gauge aluminum (minimum 3mm thick), and finished with a scratch-resistant paint (colormatched to the enclosure).
  - g. The input connectors for 70-volt systems shall be gold-plated screws with integral clamping washers.
  - h. Dimensions of each speaker shall not exceed 9" Wide x 8" Diameter x 8-1/4" Deep (with knob & bracket). Product weight shall not exceed 10 lb.
3. Pendant Loudspeaker for Cafeteria and Promenade
- a. The pendant loudspeaker shall be a JBL Control 65P/T or equal is a compact full-range, two-way pendant-type loudspeaker that provides superb sound reproduction and very consistent, wide coverage for rooms with open architecture ceilings and other locations where a pendant form factor is desired.
  - b. JBL's patent-pending Radiation Boundary Integrator® (RBI) technology, adapted from the groundbreaking VERTEC™ Series of line array loudspeakers, delivers consistent coverage of the listening area. Combining a large 200 mm (8 in) diameter waveguide with low-frequency projection apertures, the two coaxially-mounted drivers provide a seamless integration of coverage, resulting in extremely even pattern control and coverage where all listeners hear a consistent, high-fidelity sound quality. The wide 120° coverage pattern allows for the use of fewer speakers, reducing the cost of the installed system without sacrificing performance.
  - c. Excellent sound quality coupled with stylish design and easy installation makes the Control 65P/T ideal for a wide variety of applications including retail, restaurants, hotels, casinos, fitness centers, convention centers, exhibit spaces, conference rooms, atriums, museums, transit centers and other open-ceiling applications.

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- d. The Control 65P/T includes a single-point mounting system for easy and secure suspension in open-ceiling applications. Two complete hanging cable systems are included, providing both main and safety suspension cables. Include are extra-long 4.5 m (15 foot) high tensile galvanized steel wire rope having spring clips for the loudspeaker end of the cable and UL listed cable fasteners for infinitely adjustable suspension height.
  - e. The system's 130 mm (5¼ in) low-frequency driver features a polypropylene-coated cone and 25 mm (1 in) copper voice coil with vented fiberglass resin coil-former for high power handling and improved long-term reliability. The coaxially-mounted 20 mm (¾ in) textile softdome high frequency driver features internal damping for smooth extended response, along with an aluminum voice coil former and neodymium magnet assembly with ferro-fluid cooling, for high-fidelity sound quality with enhanced long-term sound level capability.
  - f. The Control 65P/T contains a high-quality 60 Watt multi-tap transformer for use on 70V/100V distributed loudspeaker lines, and is switchable for 8-ohm voice-coil direct operation.
  - g. Euro-style clip-in connectors allow for easy wiring. For protected outdoor applications, rubber boots are included to cover the input connectors, and an optional terminal cover is available for harsher locations.
4. Pendant Loudspeaker for Auditorium
- a. Loudspeaker shall be JBL AWC62 or equal compact, coaxial-driver, 2-way, highly weather-resistant full-range loudspeaker system which is ideal for speech and music-fill in a wide variety of applications, including sports facilities, racetracks, stadiums, fairgrounds, rodeos, skating rinks, themed entertainment venues, cruise ships, water parks, outdoor background music/ paging systems, swimming pools, and a wide variety of other outdoor or indoor venue types.
  - b. The AWC62 is comprised of a high-power coaxial 165 mm (6.5 in) low frequency driver and 25 mm (1 in) high frequency compression driver. The co-axial design utilizes a unique tapered pole-piece design and transitions to the cone of the low frequency driver as a large diameter pattern control horn for the high frequencies, both eliminating high-frequency beaming which is common among this category of speaker and extending pattern control to the lowest possible frequencies. The result is a coaxial speaker with wide, extremely consistent 110° coverage on a broadband basis.
  - c. Component features include a Kevlar-reinforced low frequency cone for reliability, well-damped surround for smooth frequency response, high temperature voice coil and a reduced distortion design through saturated-gap magnet geometry.
  - d. The paintable enclosure is constructed of thick, ABS plus fiberglass and is heavily braced to maximize low-frequency performance. The corrosion-resistant zinc-rich extra-thick powder coated steel grille is backed with open cell foam and high thread-count mesh, providing excellent protection in the harshest environments.

- e. The system is rated IP-56, per IEC529 when installed at minimum 5° down-tilt. The system is equipped with a 120W 70V/100V multi-tap transformer. Connection is made via outdoor-rated terminals in a recessed terminal cup. A protective terminal compartment cover is included, along with gland nut, which forms a water-tight seal with round-jacketed cable having outside diameter between 4 mm (0.16 in) and 9 mm (0.36 in).
- f. A heavy-duty weather-capable zinc-rich, thick powder coated U-type bracket is included.

U. NOISE-OPERATED GAIN CONTROLLER

- 1. Design gain controller to continuously sense space noise level and automatically adjust signal level to local speakers.
- 2. Frequency Response: 20 to 20,000 Hz, plus or minus 1 dB.
- 3. Level Adjustment Range: 20 dB minimum.
- 4. Maximum Distortion: 1 percent.
- 5. Control: Permits adjustment of sensing level of device.
- 6. Provide gain control capabilities for the Gym, Auditorium, Cafeteria, Metal Fabrication Shop, Carpentry Wood Shop, and Automotive Tech Shop.

V. OUTLETS

- 1. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.
  - a. Wattage Rating: 10 W unless otherwise indicated.
  - b. Attenuation per Step: 3 dB, with positive off position.
  - c. Insertion Loss: 0.4 dB maximum.
  - d. Attenuation Bypass Relay: Single pole, double throw. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
  - e. Label: "PA Volume."
- 2. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.
- 3. Headphone Outlet (for the Hearing Impaired): Microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed-outlet covers.

W. BATTERY BACKUP UPS POWER UNIT

- 1. Provide rack mounted unit, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.
- 2. Provide unit that supplies public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.



3. Provide battery on float charge when not supplying system and to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.
4. Provide unit that automatically retransfers system to normal supply when normal power has been reestablished for three to five seconds continuously.

X. CONDUCTORS AND CABLES

1. Jacketed, twisted pair and twisted multipair, untinned solid copper.
  - a. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
  - b. Microphone Cables: Neoprene jacketed, not less than 2/64-inch-thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
  - c. Plenum Cable: Listed and labeled for plenum installation.

Y. UNSPECIFIED EQUIPMENT AND MATERIAL.

1. Provide any item of equipment or material not specifically addressed on the Drawings or in this Document and required to provide a complete and functional installation in a level of quality consistent with other specified items. Includes Lockable Equipment Cabinet sized for up to 25% future equipment expansion.

Z. WIRING METHODS

1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
  - a. Install plenum cable.
  - b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

AA. INSTALLATION OF RACEWAYS

1. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
2. Install manufactured conduit sweeps and long-radius elbows whenever possible.

BB. INSTALLATION OF CABLES

1. Comply with NECA 1.

2. General Cable Installation Requirements:
  - a. Terminate conductors; allow no cable to contain un-terminated elements. Make terminations only at outlets and terminals.
  - b. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
  - c. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - d. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
  - e. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - f. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Do not use heat lamps.
3. Open-Cable Installation:
  - a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
  - b. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
  - c. Do not run cable through structural members or be in contact with pipes, ducts, or other potentially damaging items.
4. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

#### CC. INSTALLATION

1. Meet with the Owner prior to installation to determine and clarify all zoning requirements. Installation of the system will not begin until this meeting has occurred and the Sub-Contractor has provided a zoning plan to and received written approval from the Owner and Architect. Confirm locations of all control consoles with Owner and Architect prior to installation.
2. Design Criteria:
  - a. Provide rooms with one speaker (as indicated on the drawings) with one circuit for intercom and a dedicated address.

- b. Provide rooms with more than one speaker as indicated on the drawings (i.e. the Metal Fabrication Shop, Carpentry Wood Shop, and Automotive Tech Shop and others) with two circuits as follows:
  - 1) Dedicate the speaker nearest the front of the room to a circuit to be used as intercom.
  - 2) Install the additional speaker(s) on a separate circuit. Run these speakers series, programmed to mimic the paging, time tone and program zones as the intercom circuit
- c. Install corridor speakers on individual circuits not to exceed 12 speakers. These speakers will also be used for audio monitoring of zones in crisis situations. Strict adherence to this criteria will be enforced
- d. Program exterior speakers circuits as one individual zone
3. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
4. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
5. Equipment Cabinets and Racks:
  - a. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
  - b. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
  - c. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
6. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.
7. Wall-Mounted Outlets: Flush mounted.
8. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
9. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating. Seal back boxes and baffles at building surfaces using silicone caulking. Refer to Section 07 92 00 for Joint Sealants (part of 070001 trade bid) specifications.
10. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.
11. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

DD. GROUNDING

1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
3. Install grounding electrodes as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

EE. FIELD QUALITY CONTROL

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
3. Perform tests and inspections.
  - a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
4. Tests and Inspections:
  - a. Schedule tests with at least seven days' advance notice of test performance.
  - b. System integrator shall be responsible for performing all head end connections within the system.
  - c. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
  - d. Upon complete installation, field verify that sufficient amplitude of signal exists at a highly audible level in accordance with system manufacturer's requirements for all speaker locations.
5. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
6. Public address and mass notification systems will be considered defective if they do not pass tests and inspections.
7. Prepare test and inspection reports.
  - a. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

FF. STARTUP SERVICE

1. Engage a factory-authorized service representative to perform startup service.
  - a. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

- b. Complete installation and startup checks according to manufacturer's written instructions.

GG. ADJUSTING

1. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.
2. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

HH. DEMONSTRATION

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address and mass notification systems and equipment.

2.12 WIRELESS MASTER CLOCK SYSTEM

A. DEFINITIONS

1. NIST: The National Institute of Science and Technology.
2. PC: Personal computer.
3. UTC: Universal time coordinated. The precisely measured time at zero degrees' longitude; a worldwide standard for time synchronization.

B. PERFORMANCE REQUIREMENTS

1. Seismic Performance: Master clock and housing shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

C. SUBMITTALS

1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual, for the following:
  - a. Master unit.
  - b. Indicating clocks.
  - c. Signal equipment.
  - d. Equipment enclosures and back boxes.
  - e. Accessory components.
2. Shop Drawings: For clock systems. Include plans, elevations, sections, details, and attachments to other work.

3. Samples for Initial Selection:
  - a. Manufacturer's color photographs or color chips showing the full range of colors available for clocks, signal equipment, and control panels.
4. Delegated-Design Submittal: For the master clock and housing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - a. Detail fabrication and assembly of the master clock and housing.
  - b. Design Calculations: Calculate requirements for selecting seismic restraints.
5. Field quality-control reports.
6. Operation and Maintenance Data: For clock and program control to include in emergency, operation, and maintenance manuals.

D. QUALITY ASSURANCE

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NFPA 70.S

E. MASTER AND SECONDARY CLOCK SYSTEM

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Basis of design is Primex.
  - a. Primex
  - b. American Time
  - c. Sapling, Inc.
  - d. Simplex Grinnell
  - e. Or equal.
3. Master Clock System
  - a. Time programming shall be accomplished by way of a microprocessor-based and user-programmable master control system integrated within the Integrated Sound and System. The unit will further permit programming, diagnostics, and activity logging through connection to an external computer. The system shall be provided with a GPS antenna mounted to the roof as shown on the riser diagram with the necessary hardware-software to interface to the integrated communications system.
  - b. Correction to the second, the master time controller shall provide all secondary clocks correction to the second.
  - c. The master time controller shall provide the following functions:
    - 1) Wireless control of the slave 12 in. and 16 in. clocks located throughout the building
    - 2) Wireless repeaters shall be provided in the MDF and IDF on each floor linked via a RS485 loop between the master clock and each repeater as necessary.

- 3) Capacity for storing 900 events and up to 100 Holidays in nonvolatile memory.
  - 4) Ability to review, edit and delete events
  - 5) Review events from any entered time of day
  - 6) Events shall be programmable to any or all of (8) zone circuits
  - 7) Selection of any of (8) schedules to allow flexibility due to seasonal changes or special events
  - 8) Fully automatic Holiday program execution.
  - 9) User programmable Automatic Daylight Savings Time Change
  - 10) Separate bell duration for each zone circuit
  - 11) Latched operation of zones to control lighting or other devices
  - 12) User-programmable custom slave clock correction. Output relays rated at five amperes shall be provided on all zone circuits.
- d. The secondary clock shall be a wireless clock 12 or 16 inch depending on location. The clock will be capable of receiving a signal from multiple clocks. The clock shall receive and transmit with 915–928 MHz frequency–hopping technology. The clock is to be capable of transmitting the time simultaneously without interfering with each other. The clocks shall include automatic calibration, as well as a diagnostic function that allows the user to view the quality of the signal, the last time the clock received a correction signal, a gearbox test and a comprehensive analysis of the entire clock. The clock shall have a maximum correction time of five minutes. It shall be designed to be used with the Repeater one for each of the two floors located in the data MDF and IDF, which can be regulated via wireless communication protocol. Upon receipt of the wireless signal, the clock will immediately self–correct. The clock shall have a semi–flush smooth surface ABS case. The dial is to be made of durable polystyrene material. The crystal is to be shatterproof, side molded polycarbonate. Glass and visible molding marks are unacceptable. The clock shall have black hour and minute hands as well as a red second hand.
- e. Clocks in the gymnasium shall be 16 in. and provided with wire guards.
- f. Digital LCD Multi-Line Administrative telephones integration, the time on the Digital LCD Multi-Line Administration telephones shall be automatically and continually synchronized with the schools Master Clock System which supports all the school’s secondary clocks and class change tones. System that requires the owner to do periodic manual synchronization between the telephone systems clock and the schools Master Clock shall not be acceptable.
- g. An outside GPS antenna with 100’ cable shall be included so as to furnish a GPS time standard to the building. The electrical contractor shall be responsible for installing this antenna cable.

F. INSTALLATION

1. Mount system components with fastening methods and devices designed to resist the seismic forces indicated in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

G. IDENTIFICATION

1. Comply with Division 26 Section "Identification for Electrical Systems."

2. Color-code wires, and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.

H. FIELD QUALITY CONTROL

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections.
2. Perform tests and inspections.
  - a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
3. Tests and Inspections:
  - a. Perform operational-system tests to verify compliance with the Specifications and make adjustments to bring system into compliance. Include operation of all modes of clock correction and all programming and manually programmed signal and relay operating functions.
  - b. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
4. Clock system will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

I. ADJUSTING

1. Program system according to Owner's requirements. Set system so signal devices operate on Owner-required schedules and are activated for durations selected by Owner. Program equipment-control output circuits to suit Owner's operating schedule for equipment controlled.
2. Adjust sound-output level of adjustable signal devices to suit Owner's requirements.
3. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

J. DEMONSTRATION

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clock-and-program-control system components.



## 2.13 ELEVATOR TELEPHONE LINE FAULT MONITOR

- A. Provide Line Fault Monitor designed for connection across incoming telephone lines on systems using telephone dialers (e.g., 612) or digital communicators (e.g., 678, 678UL-B, 793 or 794) or control/communicators. It will cause a signal to be generated if the telephone line between dialer or communicator and the central station is cut or shorted, or if incoming service is otherwise interrupted. The signal can be in the form of sounding the on-premises protective system's alarm bell (when the system is ON), or the lighting of a trouble indication lamp on an optional accessory tester (such as the 664 for non-UL Listed applications).
- B. Monitor shall be mounted within a Listed control unit or other enclosure connect to intrusion alarm system on dedicated zone.

## 2.14 TWO WAY COMMUNICATIONS CALL BOXES

### A. SUMMARY

- 1. Section Includes: Area of Refuge Base Stations, call boxes and signage
  - a. The Area of Refuge Base Station is to be located at a central control point on the first floor or as determined by local Authority having jurisdiction. Rath Call Boxes are to be located on all floors above and below the first floor, ideally next to a stairwell emergency exit on each floor.
  - b. The Area of Refuge Base Station must be capable of handling a minimum of 5 Rath Call Boxes. Visual indicators on the base station allow Rescue personnel to know which Area of Rescue Call Box needs assistance. The Base Station must allow Rescue personnel to speak to all Call Boxes or individual Call Boxes.
  - c. The Emergency communication hardware shall comply with the Americans with Disabilities Act (ADA). The phone shall have the ability to be programmed with up to 5 emergency phone numbers. Upon activation of the emergency push button, a call will be automatically placed to the Base Station. If no one answers at the Base Station, the Call Box must dial a secondary location outside the building to activate two way off-site person to person voice communications.

### B. MANUFACTURERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Aiphone is Basis of Design.
  - a. Aiphone
  - b. Rath Area of Refuge
  - c. Housing Devices, Inc.
  - d. Or Equal.

### C. FUNCTIONAL DESCRIPTION OF SYSTEM

- 1. Construction
  - a. The Area of Refuge Base Station (models 2500) must have a stainless steel or powder coated steel housing, red coil cord emergency Handset, be 120vac powered, and maintain back-up power for 4 hours.

- b. The Area of Refuge Call Boxes (models 2100) must be in full compliance with Americans with Disabilities ACT (ADA). Call Boxes require a hands-free speakerphone with an LED to indicate status of call.
  - c. The Area of Refuge Call Boxes must allow the programming in of a specific location message of the Call Box. This allows Rescue personnel to know the location of the activated Call Box.
  - d. The Area of Refuge Call Boxes are to be located no higher than 48" above ground level to ensure conformance with the ADA requirements.
  - e. The Area of Refuge Call Boxes must have a Braille faceplate located no higher than 48" for front reach and 54" for side reach above ground level to ensure conformance with the ADA requirements.
  - f. The Area of Refuge Base Station must provide an audible and visual indicator that a Call Box has been activated.
  - g. The area of Refuge 24vac Power Supply model 2500-PWR24 must be capable of supplying power to a minimum of 40 Call Boxes. (does not power Base Station)
2. Mounting
- a. The Area of Refuge Base Station is to be mounted on a wall surface or flush mounted.
  - b. Areas of Refuge *Call Boxes* are to be wall surface or flush mounted.
3. Electrical
- a. The Base Station is to be powered by 120vac. Call Boxes are to be powered by Rath 24vac Power Supply model 2500-PWR24.
  - b. Call Boxes must have a battery back-up capable of providing up to 4 hours of electrical back-up in case of building power failure.
  - c. Base Station must have a battery back-up capable of providing up to 4 hours of electrical back-up in case of building power failure.
  - d. System shall be in compliance with all state and local Electrical Codes.
4. Communications
- a. The Call Boxes shall have an ADA compliant and vandal resistant speakerphone.
  - b. The Call Boxes shall be Hands-Free and be a push-button-once to talk system. Once the button has been pushed, the Call Box will call the Base Station. If no answer at the Base Station, it will automatically call preprogrammed emergency numbers. The Call Box must be capable of being programmed with up to 5 emergency numbers.
  - c. Call Box shall have Location Message capability. Call Box must have a minimum 18 second recordable message capability, programmable to play 1 or 2 times. Call Box shall notify called party of the location of the call upon being received at the emergency dispatch center.
  - d. Call Box shall be capable of allowing the called party to replay the Location Message if necessary to ensure an understanding of the caller location.
  - e. If system is not attended to 24 hours a day, the Call Box must dial a secondary location outside the building to activate two way off-site person to person voice communications.

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- f. Once call has been made (button pushed), the call can only be terminated by the called party.
  - g. Call Box must have a red LED that will light up upon push of the button. The light shall be a solid color when the Call Box is activated, and will flash when call has been answered.
  - h. The Call Box must be capable of being programmed and reprogrammed on-site and remotely.
5. Standard Call Box features:
- a. Five number programming.
  - b. Operating Temperature of between -40°F to +150°F (-40° to + 65° C)
  - c. Programmable passwords.
  - d. On-Site or Remote Programmable.
  - e. EEPROM memory to protect programming.
6. Signage
- a. System shall consist of a minimum of one photoluminescent (Part #7041) sign or one 120vac edge light sign (Part #7050), "location" and "instruction" sign (Part #7049) stating, "Area of Refuge" to clearly indicate location of designated area. A tactile sign (Part #7043 or #7044) with raised letter and Braille shall be located at entrance to Area of Refuge.
7. Monitoring
- a. Off-Site monitoring of the system shall be provided by Rath Monitoring.
  - b. Must be a UL Listed monitoring service provider
  - c. Minimum 3 year agreement for monitoring of the system.
  - d. Call Boxes shall dial Rath Monitoring at 800-xxx-xxxx.
8. Graphics
- a. Area of Refuge Base Station must include wording identifying the location of each Call Box and light an LED when a particular Call Box has been activated.
  - b. Call Box wording must include "Help Phone", "International Phone symbol" and raised Braille lettering.
- D. STARTUP SERVICE
- 1. Engage a factory-authorized service representative to perform startup service.
    - a. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
    - b. Complete installation and startup checks according to manufacturer's written instructions.
- E. ADJUSTING
- 1. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

2. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

F. DEMONSTRATION

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address and mass notification systems and equipment.

**PART 3 - EXECUTION**

3.1 GENERAL

- A. Do not install equipment and materials which have not been reviewed by the Architect. Equipment and materials which are installed without the Architect's review or without complying to comments issued with the review shall be removed from the project when so instructed by the Architect. No payment will be made for unapproved or removal if it is ordered removed. The Installer shall be responsible for any ancillary costs incurred because of its removal and the installation of the correct equipment and materials.
- B. Obtain detailed information on installation requirements from the manufacturers of all equipment to be furnished, installed or provided. At the start of construction, check all Contract Documents, including all Drawings and all Sections of the specifications for equipment requiring electrical connections and service and verify electrical characteristics of equipment prior to roughing.
- C. Equipment and systems shall not be installed without first coordinating the location and installation of equipment and systems with the General Contractor and all other Trades.
- D. Any and all material installed or work performed in violation of above requirements shall be re-adjusted and corrected by the Installer without charge.
- E. Refer to all Drawings associated with the project, prior to the installation or roughing-in of the electrical outlets, conduit and equipment, to determine the exact location of all outlets.
- F. After installation, equipment shall be protected to prevent damage during the construction period. Openings in conduits and boxes shall be closed to prevent the entrance of foreign materials.
- G. Home runs indicated are not to be combined or reduced without written consent from the Architect.
- H. All connections to equipment shall be made as required, and in accordance with the approved submittal and setting drawings.
- I. Delivery, Storage and Handling:
  1. Deliver, store, protect and handle products in accordance with recommended practices listed in Manufacturer's Installation and Maintenance Manuals.

2. Deliver equipment in individual shipping splits for ease of handling, mount on shipping skids and wrap for protection.
3. Inspect and report concealed damage to carrier within specified time.
4. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation. Meet the requirements and recommendations of NFPA 70B and the Manufacturer. Location shall be protected to prevent moisture from entering enclosures and material.
5. Handle in accordance with NEMA and the Manufacturer's recommendations and instructions to avoid damaging equipment, installed devices and finish.
6. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the Manufacturer shall be required to brace the equipment suitably to ensure that the tilting does not impair the functional integrity of the equipment.

J. Site Observation:

1. Site observation visits will be performed randomly during the project by the Architect. Reports will be generated noting observations. Deficiencies noted on the site visit reports shall be corrected. All work shall comply with the Contract Documents, applicable Codes, regulations and local Authorities whether or not a particular deficiency has been noted in a site visit report.
2. Be responsible to notify the Architect ten working days prior to closing in work behind walls, raised access floors, ceilings, etc., so that installed work can be observed prior to being concealed.
3. Areas shall stay accessible until deficiencies are corrected and accepted. Notify the Architect when all deficiencies are corrected. Return reports with items indicated as corrected prior to re-observation by the Architect.

K. Project Open House:

1. If the Owner elects to have an open house at the end of the project, provide assistance to the Owner. Cooperate and provide manpower to operate and demonstrate systems during the open house as requested by the Owner.

### 3.2 EQUIPMENT RACKS, CABINETS AND BRACKETS

- A. Securely mount equipment racks, cabinets and wall mounted relay brackets to the building structure. Proper supports such as 3/8" lag screws and expansion anchors shall be used. Proper quantity of supports shall be utilized. Dry wall screws and other types of supports not specifically approved to support equipment are specifically prohibited. Submit mounting supports for approval before installation.
- B. Position racks, cabinets, and wall mounted relay brackets in order to have minimum 3-foot clearance for easy access. Equipment racks, cabinets and relay brackets mounted on or against walls shall have 3-foot clearance in front of deepest component. Free standing equipment racks and cabinets shall have 3-foot clearance in front and rear of deepest components. Provide 3-foot clearance between free standing equipment racks or cabinets and any other obstruction to allow access from front to rear of rack or cabinet for maintenance.

- C. The Electrical Contractor shall provide cable tray over each rack and cabinet as required to facilitate a neat and orderly installation of cables and to secure the top of the racks to the structure. Cables shall drop straight down to equipment racks. Cable trays shall be secured at both ends to the structure and connected together as required for a complete contiguous installation. Utilize proper supports to support the cable tray to the building structure as well as the equipment rack and cabinet. Submit mounting supports for approval before installation.
- D. Cable Management: All cables shall enter the wiring closet to within the equipment racks and/or brackets. Secure the bundle(s) to the rack strain relief and wire management behind the patch panels and cross connect block panels. Install horizontal and side-mounted vertical cable management panels and brackets for routing and management of patch cables. Maintain EIA/TIA and BICSI standards on bundling, supporting and bend radii.
- E. Once the cabling system has been installed and terminated, install all active components and surge protected power strips into the racks, cabinets and wall mounted relay brackets.
- F. Surge Protected Outlet Strips: Mount UPS and surge protected outlet strips per Manufacturer's directions. Refer to details on the Drawings for mounting location.

### 3.3 TERMINATIONS

- A. All copper conductors of every cable shall be completely terminated at both ends.

### 3.4 CABLE PATHWAYS

- A. Install cables in pathways provided by the Electrical Subcontractor or required under execution part of this Section.
- B. Provide all equipment and cabling for a complete installed operating system. In general, pathways, outlet boxes and grounding are provided by the Electrical Sub-Contractor.
- C. All pathways provided under this Section shall comply with fill capacities as per Code, EIA/TIA 569 and BICSI.
- D. Cable bending radius shall not be less than minimum required by EIA/TIA and BICSI.
- E. Cabling installed concealed shall be supported from the building structure (e.g. cable trays, J-Hooks, etc.).
- F. Cables shall be installed no closer than 12 inches (305mm) to electrical equipment and wiring. When cables are required to cross power wiring, they shall only do so perpendicular to the power wiring. Telecommunications cabling and power wiring shall only cross each other the minimal number of times as required due to building design limitations.
- G. Clearances: Clearances between cabling and other building systems as required by EIA/TIA 569 and BICSI shall be maintained throughout the building.

- H. All cables shall be installed in a neat and workman-like manner. Cables shall be installed parallel and perpendicular to building elements.
- I. Provide expansion fittings and adequate cable slack at all building expansion joints.
- J. Fire/smoke seal all conduits, raceways, sleeves, slots, etc. where cables pass from one location to another.

### 3.5 SEALING OF PENETRATIONS AND OPENINGS

- A. Environmental Seals
  - 1. Provide seals on raceways exposed to widely different temperatures, as in refrigerated or cold storage areas. Install seal to prevent circulation of air from warmer to colder sections through the raceway.
  - 2. Provide seals under device plates for outlets on walls between conditioned and non-conditioned spaces.
  - 3. Provide outlet plate gasket seals at all work area outlets on interior and exterior walls.

### 3.6 SEISMIC SUPPORTS, SUPPLEMENTARY STEEL AND CHANNELS

- A. Provide all supports, supplementary steel and channels required for the proper Seismic installation, mounting and support of all work installed under this Section.
- B. All supports, supplementary steel and channels shall be furnished, installed and secured with all fittings, support rods and appurtenances required for a complete support or mounting system.
- C. Supplementary steel and channels shall be firmly connected to the building construction in a manner approved by the Architect prior to the installation of same. Submit to the Architect, via the General Contractor, the locations proposed for using supplementary steel and channels for the support of equipment, fixtures and raceways. The submittal shall indicate the mounting methods, size and details of the supports, channels and steel; it shall indicate also that weight which the supports, channels and supplementary steel is to carry.
- D. The type and size of the supporting channels and supplementary steel shall be of sufficient strength and size for seismic restraint and to allow only a minimum deflection in conformance with the channel and supplementary steel manufacturer's requirements for loading.
- E. All supplementary steel and channels shall be installed in a neat and workmanlike manner parallel to the walls, floor and ceiling construction. All turns shall be made with 90 degrees and 45 degrees' fittings, as required to suit the construction and installation conditions.
- F. All supplementary steel, channels, supports, and fittings, shall be Underwriters' Laboratories, Incorporated, approved, be galvanized steel and be manufactured by Steel City, Unistrut, Power-Strut, T. J. Cope, Chalfant or approved equal.
- G. Provide supports to meet the required Seismic rating as indicated under "Part One" of this Specification.

- H. Provide beam clamps with set screws (C-clamp type).
- I. Work under this Section shall be held in place by Seismic rated methods.
- J. Supporting from the roof decking will not be acceptable.
- K. Provide expansion anchors on masonry units or brick work. Power actuated supports will not be accepted.
- L. Provide stainless steel or corrosion resistant supports in corrosive areas on wet or damp areas.
- M. Support work from the building structure, independent of suspended ceilings, roof deck or other trades work. Where duct work, pipes, pipe racks, type of building construction materials or structural framing members provide obstruction or difficult support means, hanger rods shall be used in association with horizontal sections of steel support channels, in an approved manner.
- N. All work shall be installed in a rigid and satisfactory manner and shall be supported by bar hangers in frame construction or shall be fastened directly with wood screws on wood, bolts with expansion shields on concrete or brick toggle bolts on hollow masonry units, and machine screws or welded threaded studs on metal. Threaded studs of the proper type and holding capacity driven in by a power charge and provided with lock washers and nuts are acceptable for mounting of equipment on solid concrete walls or slabs.
- O. Obtain written permission from the General Contractor allowing use of power activated charges. Use only properly trained and licensed operators.
- P. Do not use power charge driven supports for any work that is to be hung from a horizontal surface without written permission from the Architect.
- Q. Preset inserts of the proper type and holding capacity shall be used in overhead slab construction wherever possible.
- R. Provide lateral supports for work to prevent excessive movement during a seismic event using rods, braces or galvanized or stainless steel cables.
- S. Pendants, supports or hanging rods longer than 12 inches (300mm) shall be laterally braced.
- T. Where installed in damp, wet and areas requiring wash down, all surface mounted panels, boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.

### 3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 26 00 00 "Identification for Electrical Systems."
  - 1. Confirm labeling scheme with the Owner prior to final labeling.
  - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.



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- B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
  - C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
  - D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
  - E. Cable and Wire Identification:
    - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
    - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
    - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
    - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
      - a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
      - b. Label each unit and field within distribution racks and frames.
    - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
  - F. Provide preprinted or computer-printed type labels with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:
    - 1. Cable Labels: Use flexible vinyl or polyester that flexes as cables are bent.

### 3.8 CABLE SUPPORTS

- A. Provide strain relief hardware for backbone cables at each floor level as they pass from one floor to the next.

- B. Provide hook and loop (Velcro) cable wraps at all panels, equipment racks and cabinets. Cable ties are specifically prohibited.
- C. Cable ties for horizontal cables shall be secured with minimum required compression in order to secure the cables properly without impeding the signal transmission rating (geometry) of the cable. Hook and loop (Velcro) cable wraps may be used in lieu of cable ties for copper cables only. Cable-ties are specifically prohibited for fiber optic cables.
- D. When pathways are not provided or specified, provide J-Hook supports from the building structure as required for cable runs to the cable drop location. Maximum distance between supports shall be five feet (1 500mm) depending on the structural elements of the building. Maximum number of cables per support shall be thirty. Provide additional supports as required when cable quantities exceed thirty and to maintain required bending radius of cables. Cables installed exposed or in areas subject to abuse (below 10 feet (3m) above finished floor) or in accessible areas shall be installed in conduit.
- E. All cables shall be supported directly from building structure. Under no circumstance shall cable be installed using cross bracing, plumbing/sprinkler pipes, ceiling systems or any other system that is not a specifically approved method to independently support cables. Cables shall not be allowed to rest on ceiling tiles, duct work, piping, etc. Supports shall be provided as required in order for cables to avoid contact with any other building system. Bundle cables in groups by Room.

### 3.9 CABLE PROTECTION

- A. Provide bushings in all metal studs and the like where cables will pass through. Bushings shall be of two-piece construction with one piece inserted through the opening and the second piece locking it into place. Single piece bushings with locking tabs or friction fit are specifically prohibited.
- B. Cables to be installed in existing enclosed open bays or furred spaces where conduit stubs are not provided shall be protected from chafing or any damage. The Installer shall verify that the warranty shall not be violated before installing any cabling in these locations.
- C. Provide cutting, coring, sleeves and bushings and seal as required at all penetrations.
- D. Fiber optic backbone cables shall be installed in inner duct.
- E. Cables damaged during installation shall not be repaired. They shall be completely replaced with new cable.

### 3.10 INSTALLATION

- A. All cabling shall be installed in conduit where indicated on plans, or shall be installed open using other methods, approved by architect, such as J-Hooks.
  - 1. Install wiring, per manufacturers recommendations. Use UL listed plenum cable in environmental air spaces including plenum ceilings.
- B. All wiring shall be new and concealed in pipe where exposed.

- C. All conduits and raceways shall have pull strings remaining after cable is pulled.
- D. Impedance and Level Matching:
  - 1. Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- E. Control Circuit Wiring:
  - 1. Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
  - 2. Make installation in strict accordance with approved manufacturer's drawings and instructions.
  - 3. The Installer shall provide necessary transient protection on the AC power feed, all station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.
- F. Weatherproofing:
  - 1. Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.
- G. Typical Layouts and requirements of the specified systems:
  - 1. Typical layout:
    - a. Equipment racks and cabinets
    - b. Backbone cabling
    - c. Headend equipment
  - 2. Typical layout of telecommunications equipment racks and cabinets.
    - a. Each equipment rack and cabinet shall contain the following equipment:
      - 1) Fiber optic patch panel
      - 2) Fiber optic cable management
      - 3) Surge protector power strip
      - 4) Patch panels - Horizontal distribution
      - 5) Horizontal distribution cable management
      - 6) Vertical cable management
      - 7) Patch cords
    - b. Provide space for the installation of network electronics equipment in the equipment racks.
    - c. Furnish and install horizontal cable management between each patch panel (fiber optics, Hub distribution, Horizontal distribution, and telephone distribution).
    - d. Furnish and install horizontal distribution patch panels in each wire center with sufficient ports to terminate all modular jacks shown on the drawings plus twenty percent spares. The exact number of modular jacks and horizontal distribution patch panels shall be obtained from the drawings.

- e. Furnish and install all equipment racks and cabinets required to support the aforementioned equipment.
  - f. The MDF room shall contain fiber optic patch panel quantities which correspond to the total number of fiber optic patch panels located in the IDF rooms.
  - g. Grounding bars shall be installed under SECTION 26 00 00. Furnish and install the required grounding to ensure that all of the aforementioned equipment is grounded and bonded.
3. Headend
- a. The headend consists of connecting hardware for the following:
    - 1) Paging System
    - 2) Master Clock System
  - b. Final terminations from IDC cross connect block panels to telephone equipment and PBX by -Telephone Company and Equipment Installer. Coordinate with Telephone Company and Equipment Installer for final terminations.
  - c. Final terminations from the IDC cross connect block panels to the headend equipment shall be provided by the headend equipment installer.
  - d. Coordinate with the headend equipment installer and the electrical contractor for:
    - 1) The installation of all the IDC cross connect block panels at the headend equipment. Installation shall be neat in appearance.
    - 2) The final terminations at the headend.

### 3.11 TRAINING

- A. As a minimum, training sessions shall consist of the following:
  - 1. General project information and review shall be by the General Foreman or Superintendent of the Trade.
  - 2. Specific system training shall be by a Factory Trained Representative.
  - 3. Provide a complete review of the project and systems including, but not limited to, the following:
    - a. In a classroom environment review each Record Drawing (use of typicals is acceptable).
    - b. Note equipment layouts, locations and control points.
    - c. Review each system.
    - d. Review system design operation and philosophy.
    - e. Review alarms and necessary responses.
    - f. Review standard troubleshooting techniques for each system.
    - g. Review areas served by equipment.
    - h. Identify color codes used.
    - i. Review features and special functions.

- j. Review maintenance requirements.
  - k. Review operation and maintenance manuals.
  - l. Respond to questions (record questions and answers).
- 4. After classroom training, walk the entire project, review each equipment room and typical locations. Explain equipment and proper operation.
- B. During the instruction period the Owner and Maintenance Manual shall be used and explained.
- C. The Owner and Maintenance Manual material shall be bound in 3-ring binders and indexed. On the edge of the binder provide a clear see-through plastic holder with a typed card indicating the Project name, the Architect's name, the installer's name and the Volume number (e.g., Vol. No. 1 of 2).
- D. Provide name, address and telephone number of the manufacturer's representative and Service Company for all items supplied so that the source of replacement parts and service can be readily obtained.
  - 1. Include copies of manufacturers and installer's warranties and maintenance contracts and performance bonds properly executed and signed by an authorized representative.
  - 2. Include copies of all test reports and certifications.

### 3.12 ACCEPTANCE DEMONSTRATIONS

- A. Systems installed under this Section shall be demonstrated to the Owner and Architect. Demonstrations are in addition to necessary testing and training sessions. Notify all parties at least 7 days prior to the scheduled demonstration. Schedule demonstrations, in cooperation with and at times convenient to all parties, so as to not disturb ongoing activities.
- B. Systems shall be tested prior to the demonstrations and each system shall be fully operational and tested prior to arranging the Acceptance Demonstration. Final payments will be withheld until a satisfactory demonstration is provided for all systems indicated or requested.
- C. If the demonstration is not totally complete, performing all functions, features and connections or interfaces with other systems, or if there is a failure during the demonstration, additional demonstrations shall be arranged. Provide and pay for all costs, labor and expenses incurred for all attendees for each additional demonstration required for acceptance and demonstration of complete system operation.
- D. Demonstrations shall be scheduled in ample time to complete all activities prior to final acceptance and Owner occupancy. Demonstrations shall take place at least 30 days prior to the scheduled project completion date and 30 days prior to owner's use and occupancy.
- E. As a minimum, provide demonstrations for systems indicated under "Work Included" under Part One of the Specifications. Provide demonstrations of additional systems as requested by the Owner, or Architect.

### 3.13 PROJECT OWNER COORDINATION

- A. Prior to Substantial Completion of the project and in ample time to address and resolve any coordination issues, request and arrange meetings between the Owner, Owner's Vendors and Consultants, Architect and General Contractor to discuss the Scope of Work for each system being provided and the interface required for a fully functional and operational system upon project completion. Initial meetings shall be scheduled three months prior to the scheduled Substantial Completion date or as soon as Submittals are submitted and reviewed for projects with shorter schedules.
- B. At these meetings the required interface with the Owner shall be reviewed, requests for information required to complete programming or for coordination shall be presented and system operation and philosophy shall be discussed.
- C. Additional meetings shall be held as requested by any party so that all issues are resolved and with the goal and intent being that all systems are fully operational and functional upon project Substantial Completion and that the responsibility for all components required is clearly established.

### 3.14 CLEANING UP

- A. Upon completion of all work, and testing, thoroughly inspect all exposed portions of the installation and completely remove all exposed labels, markings, and foreign material.
- B. The interior of all boxes and cabinets shall be left clean; exposed surfaces shall be cleaned and plated surfaces polished.
- C. Repair damage to finish surfaces resulting from work under this Section.
- D. Remove material and equipment from areas of work and storage areas.
- E. All equipment shall be clean from dirt, dust, and fingerprints prior to final acceptance.
- F. Touch up all damaged pre-finished equipment using materials and methods recommended by the Manufacturer.

### 3.15 PROJECT CLOSEOUT

- A. Provide close out submittals as required herein and in DIVISION 01 including the following close out submittals.
  - 1. Operation and Maintenance Manuals
  - 2. Record Drawings.
  - 3. Test Reports.
- B. Obtain written receipts of acceptance close out submittals submitted. Receipts shall specifically detail what is being delivered (description, quantity and specification section) and shall be dated and signed by firm delivering materials and by the Owner's Representative.

- C. Construction Waste Management
- D. Comply with Division 01 requirements for construction waste management and recycling.

3.16 SPARE PARTS/ATTIC STOCK:

A. REQUIREMENTS:

1. Provide attic stock of the following quantities and parts for each piece of equipment as follows:

<b>Equipment/Unit</b>	<b>Parts Description</b>	<b>Quantity</b>
Cables	UTP 4-pair Station Cable	1000'
	7 foot patch cables	100
Integrated Sound, PAS	Ceiling Speakers pair	1
	Exterior Speakers pair	1

End of Section

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Section 27 08 00

COMMISSIONING OF COMMUNICATIONS

**PART 1 – GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This section includes commissioning process requirements for communication systems, assemblies and equipment.
- B. Related Sections:
  - 1. Division 01 Section “General Commissioning Requirements” for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section “General Commissioning Requirements” for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section “General Commissioning Requirements” for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s role.
- B. Refer to Division 01 Section “Submittals” for specific requirements. In addition, provide the following:
- C. Certificates of readiness
- D. Certificates of completion of installation, prestart, and startup activities
- E. O&M manuals
- F. Test Reports.

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer' calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

#### 1.7 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

### PART 2 – PRODUCTS

#### 2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the communication contractor of Division 27 shall ultimately be responsible for all standard testing equipment for the communication system in Division 27. A sufficient quantity of two-way radios shall be provided by each subcontractor.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications.

### PART 3 – EXECUTION

#### 3.1 GENERAL DOCUMENTATION

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems
- B. **Red-lined Drawing:** The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawing. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be

created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.

- C. **Operation and Maintenance Data:** Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.
- D. **Demonstration and Training:** Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior to the training session.

### 3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meetings.
- C. Participate in communication systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- D. Provide information requested by the CxA for final commissioning documentation.
- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Communication system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-up task completion for owner. Distribute preliminary schedule to commissioning team members.
- G. Update schedule as required throughout the construction period.
- H. Assist the CxA in all verification and functional performance tests.
- I. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- J. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
- K. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.

- L. Participate in, and schedule vendors and contractors to participate in the training sessions.
  - M. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
    - 1. Communication Systems (example: cabling, routers, switches, fiber patch panels, software, fiber-optic cable, server racks, CAT 5E cable, CAT 6 cable, CAT 6a cable, computers, etc. to provide entire communication network) and all other equipment furnished under this Division.
  - N. The equipment supplier shall document the performance of his equipment.
  - O. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
  - P. Equipment Suppliers
    - 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
    - 2. Assist in equipment testing per agreements with contractors.
    - 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
  - Q. Refer to Division 01 Section "General Commissioning Requirements" for additional Contractor responsibilities.
- 3.3 CxA'S RESPONSIBILITIES
- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's Responsibilities.
- 3.4 TESTING PREPARATION
- A. Certify in writing to the CxA that communication systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
  - B. Certify in writing to the CxA that communication instrumentation and controls have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
  - C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
  - D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

- E. Inspect and verify the position of each device and interlock identified on checklist.
- F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.5 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Communication systems testing shall include the entire communication equipment installation, from the incoming equipment throughout the distribution system. Testing shall include all equipment and devices.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the communications contractor(s) and other contracted subcontractors, shall prepare detailed testing plans, procedures, and checklists for communication systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Communication system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

### 3.6 COMMUNICATION SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. **Equipment Testing and Acceptance Procedures:** Testing requirements are specified in individual Division 27 sections. Provide submittals, test data, inspector record and certifications to the CA.

- B. **Communication System Testing:** Field testing plans and testing requirements are specified in Division 27 Sections. Assist the CxA with preparation of testing plans.
  - C. **Communication System Testing:** Provide technicians, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item to be tested.
  - D. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:
    - 1. Cabling, switches, servers, routers, interfaces and terminals
    - 2. Master clock system
    - 3. Public address system
    - 4. Coordination and functionality with the Building Automation System/Building Management Controls System, if applicable
- 3.7 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT
- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.
- 3.8 APPROVAL
- A. Refer to Division 01 Section "General Commissioning Requirements" for approval procedures.
- 3.9 DEFERRED TESTING
- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deferred testing.
- 3.10 OPERATION AND MAINTENANCE MANUALS
- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
  - B. Refer to Division 01 Section "General Commissioning Requirements" for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.
- 3.11 TRAINING OF OWNER PERSONNEL
- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to training.

End of Section

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Section 27 41 00  
AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

1.01 APPLICABLE PROVISIONS OF THE CONDITIONS OF THE CONTRACT AND DIVISION #1, GENERAL REQUIREMENTS, GOVERN WORK IN THIS SECTION.

1.02 DESCRIPTION OF WORK

- A. The work of this Section consists of the provision of materials, labor, and equipment and the like necessary and/or required for the complete execution of audiovisual equipment and related work for this project as required by the schedules, keynotes and drawings, including, but not limited to the following:
1. Unless otherwise specified, supply only new equipment, parts and material, and protect equipment from construction dust and debris until final acceptance. Operate only as required for testing as part of installation procedure. Provision of manufactured components, installation, wiring, and testing is the responsibility of a single contractor.
  2. The system drawings indicate the general layout of the various items of equipment and their functional relationships. However, layout of equipment, accessories, and conduit systems are diagrammatic unless specifically detailed and do not necessarily indicate every item required for a complete installation. Provide any incidental equipment needed in order to result in a complete and operable system even if not specified or shown on drawings without claim for additional payment.
  3. Quantities of major installed and portable equipment, including any add- or deduct-alternates, are indicated on the system and electrical drawings. Quantities of portable equipment are indicated in schedules contained in the drawings or specifications; quantities of installed equipment are determined by examining the functional diagrams, plans, and riser diagrams.
  4. Refer to audiovisual plan drawings for receptacle back box location and quantity information. Also, refer to architectural reflected ceiling plans for exact location of ceiling-mounted devices.
  5. Verify correctness of parts lists and equipment model numbers and conformance of each component with manufacturer's specifications.
  6. Obtain permits necessary for the execution of the work. Comply with applicable local codes and regulations.
  7. Provide inserts; cover plates, etc. as required for a complete system.
  8. Supply and install strut channel hardware above finished ceiling for mounting of video projectors.
- B. Functional Requirements of Systems:
1. Gymnasium Sound and Video System
    - a. Ceiling-mounted loudspeaker set up in zones to cover the seating areas and floor area separately.
    - b. Wireless hand held microphone and XLR line input for auxiliary audio sources.
    - c. Wall-mounted button panel to control input source select and volume control.
    - d. Video projection screen and projector to show local input or overflow from Auditorium AV system
  2. Auditorium AV System
    - a. Video projection system with wall/ceiling mounted video projector to show and image on a motorized video projection screen located above the stage area.

- 1) Sources include wired HDMI input located on the stage and at the control location.
    - b. Suspended left and right program loudspeakers to playback audio from video sources and local microphone inputs.
    - c. Wired and wireless microphone systems for voice amplification.
    - d. Various input plates on the stage area for additional microphone connections.
    - e. Self-powered monitor loudspeakers for on-stage monitoring of audio sources.
    - f. Video camera location in auditorium to show stage in remote locations in the school, including:
      - 1) Green room
      - 2) Band & chorus rooms
      - 3) Cafeteria
      - 4) Gymnasium
    - g. Wall-mounted and portable control panel to control AV system.
      - 1) Power On/Off
      - 2) Video and audio source select.
      - 3) Basic audio mixing
  3. Band & Chorus Rooms
    - a. Local microphone input panel so audio can be played back in the auditorium sound system.
    - b. Classroom AV system to show video feed from auditorium
  4. Cafeteria
    - a. Local displays to show video feed from auditorium
    - b. Ceiling speakers to play back local audio and audio from video source, including auditorium feed.
- C. Related Work Specified Elsewhere:
1. Metals (05 00 00)
  2. Rough Carpentry (06 10 00)
  3. Finish Carpentry (06 20 00)
  4. Heating, Ventilating, and Air-Conditioning (23 00 00)
  5. Electrical (26 00 00)
  6. Communications (27 00 00)
  7. Structured Cabling (27 10 00)
- D. Definitions:
1. Owner: Fuller Middle School.
  2. Architect: Jonathan Levi Architects.
  3. Consultant: Acentech Incorporated.
  4. Bidder: Audiovisual contractor or other entity generating the response to this set of audiovisual bid documents.
  5. Audiovisual Contractor or Contractor: Company responsible for work under this section.
  6. Furnish: procure, and deliver the equipment to the job site, freight prepaid, for receipt, staging, and installation by others.
  7. Install: Provide, store, unpack, and securely attach or mount equipment to structure following industry standards, approved shop drawings, and manufacturer recommendations.
  8. Provide: Furnish and Install equipment.
  9. Provided by Others and Not in Contract (NIC): Work related to this contract, but will be provided by parties other than the AV Contractor.
  10. Owner-Furnished Contractor Installed (OFCl) or Owner-Furnished Equipment (OFE): Equipment furnished by the Owner for installation by the Audiovisual contractor. The

Audiovisual contractor shall be responsible for installing and integrating this equipment as detailed herein.

11. Installation Materials: Installed cable, loose cable, terminations, cable management, voice/data/video patch cords, adapters, I/O panels, cable dressing, lacing bars, copper bus bars, labels, rack shelves, rack mounts, power strips/distribution, and other materials as needed to install the systems.
- E. Equipment Furnished by Audiovisual Contractor and Installed By Others:
1. Provide the following device boxes/conduit boxes to the Electrical Contractor for installation:
    - a. Floor Boxes
    - b. Display Monitor boxes
    - c. Ceiling Speaker back boxes
    - d. Local Control Back boxes
    - e. Information Display Panel back boxes
    - f. Others as indicated on AV Contract Drawings or required

### 1.03 SUBMITTAL REQUIREMENTS

- A. General:
1. Provided in Division 01
  2. Contractor must provide four submissions as described in this specification. Those submissions include:
    - a. Bid submission
    - b. Shop drawing, bill of materials, and programming
    - c. Test reports
    - d. As-Built drawings and operation manuals
  3. Delivery Schedule:
    - a. Bid submittal package: By date specified, to include:
      - 1) Basis of bid documents, including:
        - a) Itemized equipment costs for specified equipment or APPROVED substitutions.
        - b) Qualifications/References
        - c) Certifications (including certificate of bonding, if required)
        - d) Proposed payment terms
    - b. Bill of material submission: No later than 30 days following award of contract provide the following as one unified package:
      - 1) Bill of materials
      - 2) Manufacturer product data sheets
    - c. Shop drawing submission: No later than 60 days following award of contract provide the following as one unified package:
      - 1) Shop drawings.
      - 2) Control system layouts and digital signal processing configurations.
    - d. Test result submission: One week before acceptance testing provide the following:
      - 1) System test and certification reports
      - 2) Owner's manuals with manufacturers' equipment manuals
      - 3) One (1) draft copy of user operational manuals
      - 4) One (1) draft copy of "as-built" system diagrams
    - e. As-built drawings and operational manual submission: Within 30 days after final acceptance testing visit provide the following:
      - 1) Final as-built system diagrams in hard copy and editable electronic file formats.
      - 2) Final user operational manuals in hard copy and editable electronic file formats.

- 3) Control software for AV Control System, digital signal processors, and other programmable devices. Include complete job-specific source code files.
- 4) Custom finish material samples, if applicable.
4. Unless otherwise directed by contract, do not order equipment until the bill of materials has been reviewed and approved by the AV consultant.
5. Approval for isolated items will not be considered, except by prior AV consultant authorization.
6. Rejected items and items requiring correction must be resubmitted together, unless authorized otherwise.

#### 1.04 BID SUBMITTALS

- A. As defined in Division 01.
- B. Instructions to Bidders: To be considered, Bids must be made in accord with the Architect's Instructions to Bidders and this Article.
- C. Examinations: Carefully examine the contract documents and the construction site to obtain first-hand knowledge of existing conditions. Contractors will not be given extra payments for conditions that can be determined by examining documents on-site, and will not be relieved of any obligations with respect to bid.
- D. Equipment for the project is shown on the plans, reflected ceiling plans, elevations, and functional diagrams. The contractor must develop a list of equipment for each type of space detailed on the drawings. Contractor is responsible for providing miscellaneous parts to provide a complete and working audiovisual system in each of the spaces outlined in the drawings.
- E. The system was designed around the Crestron control system. AMX or Extron is an acceptable substitute. The contractor will be responsible for providing the equipment necessary to provide a complete system if AMX or Extron is provided.
- F. Equipment:
  1. The equipment lists should not be considered all-inclusive. Only the major equipment items are provided in the list. The contractor must refer to this specification, drawings and addendums in preparing the bid response. The contractor is responsible for providing complete and working systems for each of the spaces outlined in the documents.
- G. Questions: Submit questions about the contract documents in writing. Replies requiring changes to the contract documents will be issued to bidders as addenda and will become part of the Contract. The Architect and Owner may give, but will not be responsible for oral clarifications. Questions received less than 10 days before bid date cannot be answered in writing.
- H. Acceptable Products: Model numbers and manufacturers identified herein indicate a standard of quality and performance. Other products will be considered, subject to approval of complete technical data, samples and results of independent testing of proposed equipment, submitted in accordance with Division 1 requirements and "Substitutions" section below.
- I. Substitutions: To obtain approval for substitutions and for items identified as "approved equal", submit written requests at least 10 days before bid date. Requests received after this time will not be considered. Requests shall clearly describe the product for which approval is asked, including

data necessary to demonstrate acceptability. If the product is acceptable, an Addendum may be issued to bidders.

- J. Equipment Availability: Verify with manufacturers availability and cost of equipment proposed, including equipment specified herein. No cost increases will be allowed for manufacturers' cost increases, or for substitutions required because of unavailability of proposed equipment.
- K. Performance Bond: The successful bidder will furnish a Performance Payment Bond and Labor and Material Bond, underwritten by a surety company approved by the Architect and Owner, for fulfillment of provisions of the contract.
- L. Basis of Bids:
  - 1. Submissions will be provided in electronic format described below. Electronic submissions must be supplied in Microsoft Excel. \*.xls or \*.xlsx format.
  - 2. Include a complete itemized list for each base-bid system indicating the manufacturer, model number, unit cost and total costs for specified items. Itemization of miscellaneous equipment such as cable, switches, and receptacles is not required.
  - 3. Clearly indicate the total cost, including expenses, for each individual system to allow the Owner to select any or all systems to be included in the contract. Itemization of miscellaneous equipment such as cable, switches, and receptacles is not required.
  - 4. Organize each list with the information presented, in the order that it appears in this specification, in 6 columns from left to right:
    - a. Paragraph number as it appears in this specification.
    - b. Paragraph title as it appears in this specification.
    - c. Manufacturer and model number.
    - d. Quantity.
    - e. Unit Cost.
    - f. Extension (unit cost times quantity).
    - g. Example:

Paragraph #	Paragraph Title	Manufacturer & Model Number	Qty.	Unit Cost	Extended Cost
Section 2.1	Microphones				
2.1.B	Hand-Held Microphone	xxx	#	\$x	\$xxx

- 5. At the end of each list indicate the cost of other items, such as for miscellaneous equipment, engineering, installation labor, overhead, taxes, etc.
- 6. On a separate list, indicate costs of any specified add- or deduct-alternates with the information presented in the same manner as for the base-bid system.
- 7. Include a listing of any voluntary alternates proposed by the bidder as substitutions or additions to the specified systems.
- 8. Include any notes or comments if necessary to qualify the bid.
- 9. Identify any sub-contractors and indicate the work they are to do.
- 10. Provide documentation of ability in installing similar systems. Furnish the names, addresses, and telephone numbers of the System Designer, Architect, General Contractor, and Owner on three projects similar in scope, which the Contractor has installed within the last 5 years.
- 11. Include certification of ownership and full familiarity with the operation of the following minimum test equipment. Provide a list of the manufacturer, model, and serial number for each item of test equipment required.
  - a. Audio Test Equipment:

- 1) SMAART, EASERA or similar measurement platform that includes a laptop computer, audio preamp, Type 1 measurement microphone, cables, and stands, to complete the system test.
  - 2) AC impedance bridge.
  - 3) Sound level meter and octave band filter set.
  - 4) Digital Multimeter.
  - 5) Calibrator with appropriate microphone adapter similar to General Radio, Norsonic, or Rion calibrators.
  - 6) Random or pseudo-random pink noise generator.
  - 7) Plug and cable tester (suggested: Whirlwind DCT-9 or PylePro PCT40).
  - 8) Loudspeaker polarity indicator (suggested: BSS Audio AR130,).
- b. Video Test Equipment:
- 1) Photometer with luminance and illuminance probes.
  - 2) TriStimulus Color Analyzer with Laptop computer (suggested: Sencor OTC1000-CM).
  - 3) Multi-frequency computer RGB test pattern generator (suggested: Extron VTG-300R, VTG-400D or VTG-400DVI).
  - 4) HDMI test pattern generator (suggested: Quantum Data 780BH)
  - 5) HDMI cable test instrument similar to the Quantum Data 780BH.
  - 6) Coaxial cable test kit (for testing whether in-place cable will support SDI signals): FM Systems CTG-500 kit.
- c. Video Studio/Production Test Equipment:
- 1) Camera Test & Setup Charts (DSC Labs or equal; Grayscale, Colorbar, Skin Tone).
  - 2) Handheld Waveform/Vectorscope (suggested Leader LV5333).
  - 3) Handheld HD Generator (Hamlet Axiom or equal).

M. QUALITY ASSURANCE

1. Project Management: Maintain the same person in charge of work throughout installation.
2. Contract Documents: Maintain a complete set of system drawings and specifications at the site during installation.
3. Fabrication and Installation: Completely fabricate equipment racks and subassemblies in contractor fabrication shop. Make field connections of audio, video, and control wiring including microphone, line level, loudspeaker, video, and control system circuits to equipment, equipment racks, and connection panels. Continuously supervise the installation and connection of cable and equipment.
4. Contractor Qualifications: To be considered qualified for this work; the contracting firm must be experienced in the provision of audiovisual systems similar in complexity to those required for this project, and meet the following:
  - a. The Contractor's primary business is the provision, fabrication, and installation of professional audiovisual and related systems.
  - b. The Contractor has been regularly engaged in the installation and service of professional audiovisual presentation systems for a period of at least five years.
  - c. The Contractor is an authorized dealer for the specified Audiovisual Control System systems.
  - d. The contractor employs a Certified programmer for programming Audiovisual Control System, as required.
  - e. The Contractor is, at a minimum, Avixa certified solution provider, with at least (1) CTS-I and (1) CTS-D certified employee on-site for the duration of the installation.



- f. The contractor has a Crestron/Extron/AMX/etc. Certified Installer onsite during the installation and termination of HDBaseT or similar digital transmission systems (DigitalMedia, XTP, DTP, or DGX) equipment, as required.
- g. At the request of the Architect, demonstrate the following capabilities:
  - 1) Adequate plans and equipment to complete the work.
  - 2) Sufficient staff with appropriate technical experience to oversee and execute the work.
- 5. Subcontractors: The Contractor may arrange for sub-contract field and special shop work to be done by others.

#### 1.05 SUBSTITUTIONS

- 1. General: The Contractor has the burden of proving, at the Contractor's own cost and expense and to the satisfaction of the Architect, that the proposed product is similar and equal to the named product.
- 2. Basis:
  - a. Requests for acceptance of proposed equivalents made following the award of bid will be considered by the Architect only in the following cases:
    - 1) The named products cannot be obtained by the Contractor because of strikes, lockouts, bankruptcies or discontinuance of manufacturer and the Contractor makes a written request to the Architect for consideration of the proposed equivalent.
    - 2) The proposed equivalent, in the opinion of the Architect, is equal or superior to the named product and its use is to the advantage of the Owner.
  - b. A formal request must be made for the substitution documenting fully the above reason. Include complete data on the proposed substitution substantiating compliance with the Contract Documents including: product identification and description, performance and test data, references and samples where applicable, and an itemized comparison of the proposed substitution with the products specified or named by Addenda, with data relating to Contract time schedule, design and artistic effect where applicable, and its relationship to separate contracts. Accompany the request by accurate installed cost data on the proposed substitution in comparison with the product specified.
- 3. Consideration:
  - a. A request for substitution is a representation by the Contractor that:
    - 1) The Contractor has personally investigated the proposed substitution and determined that it is equal or superior to that specified.
    - 2) The Contractor will provide the same warranty for the substitution that would be for that specified.
    - 3) The cost data presented are complete and include related costs under this Contract, but exclude costs under separate contracts and exclude Architect's re-design costs, and that the Contractor waives claims for additional costs related to the substitution, which subsequently become apparent.
    - 4) Indicate if there will be any cost impact on work by other trades.
    - 5) The Contractor will coordinate the installation of the accepted substitute, making such changes as may be required for the Work to be complete.
  - b. Change Order modifying the Specifications will document an accepted substitution. The Contract Price will be changed only if the substitution results in cost savings to the Owner.

1.06 SHOP DRAWING AND BILL OF MATERIAL SUBMITTALS

- A. Coordinate submittals with requirements set forth in Section 00 10 00 Solicitation.
- B. CAD drawings will be in current AutoCAD .dwg format (with bound XREFs) or portable document format (PDF). Other submissions will be provided as PDFs, unless otherwise stated.
- C. Shop Drawings and Bill of Materials Submittals:
  - 1. General:
    - a. The following is required for approval, prior to ordering product, fabrication, and installation. Submit complete and at one time. Isolated items will not be considered for approval, except by prior authorization. Rejected items and items requiring correction must be resubmitted at one time, except by prior authorization.
    - b. Submittals shall be provided as complete electronic PDF files that include the following:
      - 1) A single collated file of the Bill of Materials for each system, listed in the order it appears in this specification, configured to print on standard 8-1/2" x 11" or 11" x 17" paper.
      - 2) A single collated file of cut sheets for equipment listed in this specification configured to print on standard 8-1/2" x 11" paper.
      - 3) A single collated file containing drawings configured to print as a full-size set at project standard sheet size.
      - 4) Control system touch panel layouts, as identified below.
      - 5) Digital signal processing layouts, as identified below.
    - c. The diagrams and details included with these specifications, modified to reflect the stated requirements and to reflect the details of the system as awarded, and including additional required information, may be used in preparing shop drawings. Drawings that are submitted without the necessary modifications will be rejected.
  - 2. Bill of Materials and Catalog Data Sheets:
    - a. Bill of Materials and Catalog Data Sheets of manufactured items. At the end of the Bill of Materials include Catalog Data Sheets ("cut" sheets) for product arranged in the order listed in the specifications and in the Bill of Materials. Include a cover page identifying the project and submittal. Organize the Bill of Materials in 6 columns from left to right:
  - 3. Paragraph number as it appears in this specification.
    - 1) Paragraph title as it appears in this specification.
    - 2) Manufacturer.
    - 3) Model number.
    - 4) Quantity.
    - 5) Comments (if any are needed).
    - 6) Example:

Paragraph #	Paragraph Title	Manufacturer	Model No.	Qty.	Comments
Section 2.1	Microphones				
2.1.B	Hand-Held Mic	xxx	xxx	#	

- b. Audiovisual Control System and Digital Signal Processing:
  - 1) Detailed control panel layouts and control logic notes, prepared by the control system programmer:
    - a) Provide tree diagrams indicating signal flow for review and approval by Owner and AV Consultant.

- b) Upon approval of the above by AV Consultant, and prior to beginning control system code development, provide color draft set of control system touch panel layout diagrams (Graphic User Interface) for review and approval by Owner and AV consultant, noting comments from prior review. Include text, buttons, colors, images, and backgrounds as well as page flips, sub-pages, and overall page logic flow.
- c) Upon approval of the above by AV Consultant, provide control system touch panel programming file for final review and approval by Owner and AV consultant, noting comments from prior review.
- 2) Detailed layouts for digital signal processors:
  - a) Signal flow diagrams.
  - b) Detail presets and interconnection to audiovisual control system.

D. Samples:

- 1. Finish for control panels, racks, cabinets, and loudspeaker grilles.
- 2. Mechanical connectors for use in wiring.

#### 1.07 TEST REPORT SUBMITTALS

- A. Test Reports: Upon completion of SYSTEM PERFORMANCE TESTS AND ADJUSTMENTS specified in PART 3 - EXECUTION, submit for approval in writing test results including numerical values for measurements. Also submit written certification that the installation conforms to specifications, is complete and operable, and is ready for FINAL ADJUSTMENTS AND ACCEPTANCE TESTS specified in PART 3 - EXECUTION. Provide three (3) copies unless otherwise specified.

#### 1.08 AS-BUILT DRAWING AND OPERATION MANUAL SUBMISSIONS

- A. Operation and Maintenance Data - Coordinate with Section 01700
  - 1. Draft Copies: At time of FINAL ADJUSTMENTS AND ACCEPTANCE TESTS specified in PART 3 - EXECUTION, provide draft copies of specified diagrams, schedules, and manuals for inspection during demonstration and acceptance testing. Submit final copies of documents within 30 days of project acceptance date. Drawings shall be drawn using the current version of AutoCAD. For Contractor-prepared drawings, schedules and instructions provide (1) draft copy and (2) final copies in electronic format for inclusion in the specified Complete Instruction and Maintenance Manual.
  - 2. Functional Diagrams: Simplified single line block diagram showing interconnection of major equipment components and functional relationships. Illustrate receptacles, patch panel jacks, attenuators, transformers, switches, and loudspeakers. Key each patch panel jack to the patch bay by row and jack number. Diagram shall not illustrate terminal or interconnection cable number designations. The Functional Diagram included with these specifications, modified to exclude details, transformer tap designations, etc., and to provide the information described above and any as-built changes, is suitable for this purpose.
  - 3. As-Built Diagrams:
    - a. The intent of the diagrams is to provide sufficiently clear and complete information that a technician of average skill may efficiently troubleshoot and service the system, even if unfamiliar with the installation.
    - b. Provide drawings showing terminal blocks, connectors, relays, switches, transformers, attenuators, equipment components, and wires. Label devices with manufacturer, model number, and reference number (e.g. "SW 15," "TB 6"); reference numbers shall be consistent across drawings with no repetitions. As a minimum, provide an

- expanded version of the functional diagrams with cables fanned out at termination points and labeling as specified above; provide additional drawings where system complexity does not permit complete information to be shown legibly on an individual sheet no larger than the project sheet size. Provide labels for cables continued onto another drawing, indicating termination device, terminal numbers, and drawing sheet on which the termination is shown.
- c. As-built drawings are to include full connection information for each termination of conductors within a cable, either on the drawing itself via cable breakouts or by designating the connection type and providing separate details for each connection type.
  - d. Provide layout drawings of panels and other custom assemblies containing switches, relays, terminal blocks, receptacles, etc., using reference numbers to identify physical locations of devices or label devices with reference numbers in a location visible while viewing cable terminations. On wiring diagrams, label conductors within cables for insulation color or other identifier. Label connectors, barrier strips, switches, relay sockets, etc., for terminal number. If device does not provide terminal designations, provide key diagram for reference.
- 4. Receptacle Location Plan: Plan of area showing locations and designations of receptacles.
  - 5. Building Plan: Plan drawing of the building indicating the areas covered by the various zone volume controls.
  - 6. Patch Panel Assignment Schedule: Mount a typed schedule of patch panel assignments behind acrylic at the equipment racks.
  - 7. Spare Parts List: List of consumable spare parts (projector lamps, air filters, etc.) with part numbers.
  - 8. Control Setting Schedule: Fully document the settings of non-user-adjustable controls. This includes power amplifier gain controls, equalizer settings, etc.
  - 9. Complete Instruction and Maintenance Manual: Prepare in the form of an instructional manual for use by Owner's personnel. Provide one (1) draft copy and two (2) final copies unless otherwise specified.
    - 1) Original Owner and Maintenance Manuals provided from manufacturer or high-quality color reproductions.
  - b. Drawings: Provide sequenced bound drawings in project standard size.
- 10. Content of Manuals:
    - a. Provide a table of contents arranged in systematic order. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
    - b. Contractor, name of responsible principal, address and telephone number.
    - c. Certificate of Warranty for the system as a whole as well as copies of the manufacturer's warranty for each equipment item.
    - d. Service Contract. Include a preliminary schedule for the specified semi-annual site visits.
    - e. Complete as-built diagram(s) for systems.
    - f. Functional Diagram(s).
    - g. Receptacle Location Plan(s).
    - h. Patch Panel Assignment Schedule.
    - i. Building Plan(s).
    - j. Original copies, high-quality laser printer printouts of PDF files, or high-quality photocopies of manufacturers' installation, operation, and service manuals, including schematic diagrams for each equipment item.
    - k. Shop drawings of custom-fabricated items.
    - l. Control Setting Schedule.
    - m. Audiovisual Control System:

- 1) Color printouts of touch screens control panel graphic layouts, as installed.
  - 2) Listing of system brand, models and associated peripherals.
  - 3) DVD or USB flash drive containing the master program for the system, the touch screen display program (including macros), programming, communication, or other project-specific software required for re-programming, and a limited license agreement for the use and modification of contractor-generated source code in connection with the maintenance and modification of the system for which it was written.
- n. Software for Programmable Devices: Where a computer has been used in programming system components, provide DVD or USB flash drive containing the software, instructions for making interconnections to the programmed devices for the purpose of modifying the programming, and a limited license agreement for the use and modification of contractor-generated source code in connection with the maintenance and modification of the system for which it was written.
- o. Applicable software and hardware licenses to be documented and original copies of the licensed provided to owner.

#### 1.09 JOB CONDITIONS

- A. Sequencing and Scheduling:
1. Coordinate work with adjacent work of other trades to facilitate construction and prevent conflicts.
  2. Afford other trades reasonable opportunity for installation of work and for the storage of materials.
  3. Staff the job to keep pace with the other Trades.
  4. Abide by the decision of the Architect in case of conflict or interference by other trades.
  5. Refuse: Remove refuse from the job site to the satisfaction of the Architect and Owner.
- B. Insurance on the work of this specialty trade shall be provided as specified in Section 00810.

#### 1.10 WARRANTY

- A. Warrant equipment to be free of faulty workmanship and defects, and from damage due to contamination by construction dust and debris for a minimum period of one year from date of final acceptance.
- B. Warrant repairs to "existing" equipment for a period of 90 days.
- C. Emergency service: Within 24 hours of notification, restore the system to operation, replacing defective materials and repairing faulty workmanship. Make temporary repairs and provide loaner equipment at no charge if defective materials cannot be permanently replaced or repaired within this 24 hour time period.
- D. Emergency service: alternate text for 24/7 operations.
- E. Paint and exterior finishes, fuses, lamps, and projection lamps excluded from above warranties except when damage or failure results from defective materials or workmanship covered by warranty.
- F. The minimum warranty provisions specified above shall not diminish the terms of individual equipment manufacturers' warranties.

#### 1.11 SERVICE CONTRACT

- A. Provide a one-year service contract to commence after acceptance of installation without additional cost. Service to include two semi-annual visits to the site for routine adjustment and maintenance of equipment. Provide a preliminary schedule for the semiannual visits.
- B. Toward the end of each year's Service Contract, provide the owner with a proposal for continued service during the next year.

#### 1.12 TRAINING

- A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.
- B. During tests and adjustments, permit the Owner's personnel to observe. When feasible explain the significance of each test.
- C. Provide sufficient training to personnel selected by the Owner on operation and basic maintenance of systems and equipment. Explain operation of control systems, set-up, and operation of individual pieces of equipment and functions of overall systems.
- D. Separate from the bid response quotation; provide an hourly cost for additional training.

#### 1.13 INSPECTION

- A. Notify the Architect of any defects in work by other trades affecting installation.

### PART 2 - PRODUCTS

#### 2.01 MICROPHONES AND ACCESSORIES

- A. Wireless Microphone System
  - 1. Wireless Microphone Receiver:
    - a. Predictive switching diversity.
    - b. Intelligent scanning automatically finds and deploys the cleanest frequencies to transmitters over IR sync.
    - c. Front panel gain adjustment buttons.
    - d. AES 256-bit encryption-enabled.
    - e. Front panel LCD menu and controls with lockout feature.
    - f. Audio and RF LED meters with peak indicator.
    - g. Built-in limiter circuitry prevents digital audio clipping from excessive signal levels.
    - h. Remoteable ½ wave antennas.
    - i. Minimum Overall Performance Requirements:
      - 1) Frequency Response: 20-20,000 Hz.
      - 2) Working Range: 330 ft, minimum.
    - j. Acceptable Products:
      - 1) Shure ULX-D series receiver with UA820 half-wave antennas, as required. Provide channel count, as required.
      - 2) Approved equal.
  - 2. Handheld Microphone/Transmitter

- a. Handheld wireless microphone.
  - b. Frequency and power lockout.
  - c. Acceptable Products:
    - 1) Shure ULXD2/SM58 with SB900 rechargeable battery and SBC200 battery charger.
    - 2) Approved equal.
  3. Body-Pack Transmitter:
    - a. Backlit LCD with easy to navigate menu and controls.
    - b. Rugged metal construction.
    - c. Detachable  $\frac{1}{4}$  wave antenna.
    - d. Frequency and power lockout.
    - e. Acceptable Products:
      - 1) Shure ULXD1 with SB900 rechargeable battery and SBC200 battery charger.
      - 2) Approved equal.
  4. Earset Microphone:
    - a. Miniature microphone with headband omnidirectional capsule.
    - b. Frequency response: 20-20,000 Hz.
    - c. Equivalent Noise: 24 dbA.
    - d. Acceptable Products:
      - 1) Countryman H6 with appropriate transmitter connector.
      - 2) Approved equal.
  5. In-Line Antenna Amplifier:
    - a. Acceptable Products:
      - 1) Shure UA834WB.
      - 2) Approved equal.
- B. Ceiling Microphone (Monitor)
1. Cardioid directional condenser microphone mounted on flexible 4-inch flexible gooseneck.
  2. Minimum Performance Characteristics:
    - a. Cardioid polar pattern.
    - b. Frequency Response: 50 to 17,000 Hz.
    - c. Output Impedance: 180 ohms.
    - d. Sensitivity: -35.0 dBV/Pa (17.8 mV).
    - e. Maximum SPL: 124.2 dB.
    - f. Signal to Noise Ratio (ref 94 dB SPL): 66dB.
  3. Provide color as directed by architect.
  4. Acceptable Products:
    - a. Shure MX202x/C.
    - b. Audio-Technica U853A.
    - c. AKG HM1000.
    - d. Approved equal.
- C. Gooseneck Microphone with Desktop Base
1. Characteristics:
    - a. Cardioid directional condenser microphone mounted on flexible gooseneck with desktop base, programmable switch, and removable windscreen.
    - b. Matte-black finish, with 18" overall length.
    - c. Gooseneck flexible at top and bottom, with rigid center section.
    - d. 9 to 52 VDC phantom power.
  2. Acceptable Products:
    - a. Shure MX418D/C with preamp, and windscreen.

- b. Approved equal.
- D. Handheld Microphone
  - 1. Vocal microphone useable on microphone stand or hand-held for live performance, sound reinforcement, and recording.
  - 2. Cardioid dynamic directional characteristic.
  - 3. Built-in wind screen and shock mount.
  - 4. Supply with 25 ft. cable and hardware for stand mounting.
  - 5. Acceptable Products:
    - a. Shure SM58.
    - b. Sennheiser E825S.
    - c. AKG D5.
    - d. Audio-Technica AT2010.
    - e. Approved equal.
- E. Microphone Floor Stands:
  - 1. Black finish with tripod base and boom arm.
  - 2. Acceptable Products:
    - a. Ultimate Pro T-T.
    - b. K&M 210/9.
    - c. AKG equivalent.
    - d. Approved equal

## 2.02 AUDIO MIXERS AND PREAMPS

- A. Audio Recorder
  - 1. Rack mountable audio recorder with balanced audio inputs and outputs.
  - 2. Features:
    - a. Records to SD/SDHC and USB media in MP3 and WAV (up to 24-bit/44.1kHz).
    - b. Balanced and unbalanced inputs and outputs.
    - c. Front panel USB connection.
    - d. Dual Record feature (records to two media options simultaneously for primary and backup recording).
  - 3. Acceptable Products:
    - a. Denon DN-300R.
    - b. Approved equal.
- B. Digital Mixing Console (Auditorium)
  - 1. Professional quality audio mixing console designed for live sound reinforcement, recording and reproduction of multi-channel sound effects, and stereo recording. Includes 32 input modules with direct outputs and insert points. All console assembly and construction performed completely by console manufacturer.
  - 2. Features:
    - a. Option slot module with 64/64 channel Dante I/O.
    - b. 4 Stereo effects engines.
  - 3. Mono Inputs:
    - a. Linear fader, gain sensitivity adjustment, and channel On button.
    - b. High-, mid-, and low-frequency equalizer controls.
    - c. Level LEDs: Illuminate green at dB below clipping.
    - d. Assignment to group and program outputs with pushbuttons and pan pot.



- e. Balanced inputs, with 3-pin "XLR"-type connectors (mic) and switchable 48 volt phantom power; separate balanced inputs, with TRS phone jacks (line).
  - 4. Group Outputs:
    - a. Each with individual linear motion faders, LED bargraph meter, channel On buttons.
    - b. Stereo Master Output:
    - c. Two program outputs (L & R) with dual motion fader and two LED bargraph meters.
    - d. Monitor section with volume control, source selector buttons, and stereo headphone, studio, and control room monitor outputs.
  - 5. Minimum Performance Requirements:
    - a. Frequency Response: 20-60,000 Hz,  $\pm 0.5$  dB (at +4 dBm output with equalization set in flat position).
    - b. Hum and Noise: -126 EIN, -88 dB with one group fader and one input fader at nominal level (20-20,000 Hz, input termination of 150 ohms, all output assign switches ON, input sensitivity switches at "-60").
    - c. Distortion: 0.008% THD at 1,000 Hz max gain.
    - d. Maximum Output: +22 dBu.
  - 6. Acceptable Products:
    - a. Soundcraft Performer 3 provided with Dante I/O card, MAD1 card, and configured iPad control app. Provide with one Soundcraft Compact Stagebox with MAD1 card and 32 microphone inputs and 16 line outputs.
    - b. Allen & Heath GLD-112 w/ Dante card and configured iPad control app and digital stage box.
    - c. Approved equal.
- C. Rack Mount Audio Mixer
- 1. 10-Channel Rackmount Mixer with Bluetooth.
  - 2. Features:
    - a. 4 XLR inputs; 2 in the front.
    - b. Pre-fader and post-fader aux sends; stereo aux return.
    - c. Bluetooth streaming with simple single-button pairing.
    - d. Frequency Response: 20 Hz – 50 KHz,  $\pm 0.5$  dB.
    - e. Dynamic Range: 108 dB.
    - f. THD+N: < 0.005% (Mic/Line Input to Main Out)
  - 3. Acceptable Products:
    - a. DN-410X.
    - b. Approved equal.

## 2.03 AUDIO PROCESSING EQUIPMENT

- A. Digital Audio Signal Processor Type 1
- 1. Computer controlled digital signal processor.
  - 2. Provide system with inputs and outputs as indicated on the functional drawings.
  - 3. Features:
    - a. Selectable audio inputs (balanced line level audio or microphone level).
    - b. Any input assignable to any output.
    - c. 24-bit DSP capable of limiters, matrix routing, delay, parametric/graphic equalizers, and high/low shelf equalization.
    - d. RS-232 control port.
    - e. Logic input/outputs for control.
    - f. Configurable card frame for I/O cards.
  - 4. Minimum Performance Requirements:

- a. Frequency Response: 20-20,000 Hz,  $\pm 0.5$  dB.
  - b. Distortion: 0.01% THD, 20-20,000 Hz, +10 dBu.
  - c. Dynamic Range: 105 dB minimum, (A-weighted, 20Hz to 20kHz).
  - d. Maximum Output: +24 dBu.
  - e. Dante digital audio networking.
5. Acceptable Products:
- a. BSS BLU-806DA configured as shown on drawings..
  - b. Biamp Tesira Server-IO with Dante audio network card, and audio input/output cards configured, configured as shown on drawings.
  - c. Symetrix Edge configured as shown on drawings.
  - d. QSC Qsys configured as shown on drawings.
  - e. Approved equal.
- B. Digital Audio Signal Processor Type 2
1. Computer controlled digital signal processor.
  2. Provide system with inputs and outputs as indicated on the functional drawings.
  3. Features:
    - a. Selectable audio inputs (balanced line level audio or microphone level).
    - b. Any input assignable to any output.
    - c. 24-bit DSP capable of limiters, matrix routing, delay, parametric/graphic equalizers, and high/low shelf equalization.
    - d. RS-232 control port.
    - e. Logic input/outputs for control.
    - f. Configurable card frame for I/O cards.
  4. Minimum Performance Requirements:
    - a. Frequency Response: 20-20,000 Hz,  $\pm 0.5$  dB.
    - b. Distortion: 0.01% THD, 20-20,000 Hz, +10 dBu.
    - c. Dynamic Range: 105 dB minimum, (A-weighted, 20Hz to 20kHz).
    - d. Maximum Output: +24 dBu.
  5. Acceptable Products:
    - a. BSS BLU-160 configured as shown on drawings, provide with BSS BLU-10 (color to be approved by Architect) as indicated on AV drawings.
    - b. Biamp Tesira Server-IO with Dante audio network card, and audio input/output cards configured, configured as shown on drawings.
    - c. Symetrix Edge configured as shown on drawings.
    - d. QSC Qsys configured as shown on drawings.
    - e. Approved equal.
- C. Microphone Preamp
1. Dual channel microphone preamplifier with line-level outputs.
  2. Minimum Performance Requirements:
    - a. Balanced XLR Microphone Inputs
    - b. Independent Controls for Each Preamplifier
    - c. Front-Panel 20 to 60 dB Gain Control
    - d. Switch-selectable 48 Volt Phantom
    - e. Switch-Selectable 15 dB Input Pad
    - f. Switch-Selectable Polarity Reversal
    - g. CLIP Indicators for Peaks 3 dB Below Clipping
    - h. Balanced Line-Level Outputs
  3. Acceptable Products:
    - a. Radio Design Labs HR-MP2A with PS-24AS power supply.

- b. Extron MP101 (one per microphone) with power supply.
  - c. Approved equal.
- D. Line Level Input Adapter
- 1. Stereo input to convert a consumer-level audio input to professional level mono output.
  - 2. Minimum Performance Requirements:
    - a. Frequency Response: 50-20,000 Hz  $\pm$ 1 dB.
    - b. Decora mount.
    - c. Outputs: Balanced, 600 ohm load, +22 dBv max.
  - 3. Acceptable Products:
    - a. Radio Design Labs DS-CIJ3 with mounting hardware. Color to be approved by Architect.
    - b. Approved equal.

## 2.04 AUDIO DISTRIBUTION AND POWER AMPLIFIERS

- A. 1-Channel Audio Amplifier
- 1. Single-channel power amplifier with continuous average output power of 60 watts (minimum) at 70-volts with a total harmonic distortion of 0.1% @ 1 kHz.
  - 2. Features:
    - a. Convection cooled, fanless operation.
    - b. Mono operating mode.
  - 3. Minimum Performance Requirements:
    - a. Voltage Gain (dB): 35.
    - b. Input Sensitivity: +4 dBu.
    - c. Distortion: Less than 0.1%.
    - d. Frequency Response: 80Hz to 20kHz, +1/-3dB.
    - e. Damping Factor: Greater than 100.
    - f. Noise (20-20,000 Hz) <-90dB.
    - g. Input Impedance: 10k ohms unbalanced/balanced.
  - 4. Acceptable Products
    - a. Extron XPA-601-70.
    - b. LabGruppen Lucia 60/1-70.
    - c. QSC SPA2-60.
    - d. Approved equal.
- B. 4-Channel Audio Amplifier
- 1. Four-channel power amplifier with continuous average output power all channels driven of 5000 watts/ (minimum) at 4-ohms, 8-ohms, or at 70-volt (1250W/channel).
  - 2. Features:
    - a. Frequency Response (8 Ohms, 20Hz-20kHz): +/- 0.25 dB.
    - b. Signal To Noise Ratio (A-weighted): > 108 dB.
    - c. THD (at full rated power, 20Hz-20kHz): 0.35%.
    - d. Voltage Gain: 34 dB.
    - e. Damping Factor (20 Hz to 100 Hz): >1000.
  - 3. Input Impedance (nominal balanced, unbalanced): 10 kOhms, 5 kOhms.
    - a. Load Impedance (Stereo/Dual Mode):2-16 Ohms; 70Vrms and 100Vrms.
    - b. Load Impedance Bridge Mono: 4-16 Ohms; 140Vrms and 200Vrms.
    - c. Cooling: Continuously variable speed forced air, front to back airflow.
    - d. Maximum Fan Noise (re dBA SPL @ 1M): 45.
  - 4. Acceptable Products:

- a. Crown DCi 4|1250N.
  - b. Approved equal.
- C. 2-Channel Audio Amplifier
- 1. Two-channel power amplifier with continuous average output power all channels driven of 600 watts (minimum) at 4-ohms or 8-ohms (300W/channel).
  - 2. Features:
    - a. Frequency Response: 8 Ohms, 2Hz-40kHz.
    - b. Signal To Noise Ratio (A-weighted): > 112 dB.
    - c. THD (at full rated power, 20Hz-20kHz): 0.05%.
    - d. Gain: 32 dB.
    - e. Cooling: Forced air, with temperature controlled fan.
  - 3. Acceptable Products
    - a. Crown DCi 2|300.
    - b. LabGruppen equivalent.
    - c. QSC equivalent.
    - d. Approved equal.
- D. 35W Attenuator
- 1. Single gang 70V loudspeaker attenuator.
  - 2. Features:
    - a. 10 step auto transformer.
    - b. UL listed.
    - c. Wall Plate with dial scale.
    - d. 35W power rating.
    - e. 27 dB attenuation.
  - 3. Acceptable Products:
    - a. Atlas Sound AT35.
    - b. Approved equal.
- E. Headphone Amplifier
- 1. 4-Channel headphone distribution amplifier.
  - 2. Features:
  - 3. Acceptable Products:
    - a. PreSonus HP4.
    - b. AKG HP4E.
    - c. Aphex Headpod 4.
    - d. Approved equal.

## 2.05 LOUDSPEAKERS

- A. Auditorium Line Array Loudspeakers
- 1. Two way line array element.
  - 2. Minimum Performance Requirements:
  - 3. Sensitivity: 90 dB (1W/1m)
  - 4. Max SPL: 122 dB Peak, 1m
  - 5. Dispersion: 100° H
  - 6. Freq. Response: 70 Hz to 20 kHz
  - 7. One 8" low frequency transducers and two 1" high frequency compression drivers.
  - 8. Enclosure: Multi-ply hardwood, perforated metal grille
  - 9. Acceptable Products:

- a. JBL VRX928LA with JBL suspension frame and rigging hardware as required. Coordinate color with Architect.
  - b. Approved equal.
- B. Auditorium Subwoofer
1. Minimum Performance Requirements:
    - a. Sensitivity: 91 dB (1W/1m).
    - b. Freq. Range: 35 Hz to 250 Hz.
    - c. Max SPL: 126 dB peak.
    - d. Power: 1600 W PGM
  2. Acceptable Products:
    - a. VRX915S with rigging hardware as required. Coordinate color with Architect.
    - b. Approved equal.
- C. Ceiling Loudspeaker (S1, hard ceiling)
1. Two-way loudspeaker with separate low- and high-frequency cones and voice coils, polypropylene cone, and synthetic rubber surround; with attached 70 volt line matching transformer, enclosure, and narrow ring grill.
  2. Minimum Performance Requirements:
    - a. Frequency Response: 75-20,000 Hz,  $\pm$  10 dB, on axis.
    - b. EIA Sensitivity: 89 dB.
    - c. Power Handling Capacity: 150 watts.
    - d. Voice Coil Impedance: 8 ohms.
    - e. Transformer Taps: 7.5, 15, 30, and 60 watts.
  3. Acceptable Products:
    - a. JBL Control 26 CT.
    - b. Atlas Sound FAP62T.
    - c. QSC AC-C6T.
    - d. Approved equal.
- D. Ceiling Loudspeaker (S1, ACT ceiling)
1. Low-profile lay-in 2' x 2' ceiling tile loudspeaker.
  2. Minimum Performance Requirements:
    - a. Frequency Response: 100-16,000 Hz,  $\pm$  10 dB, on axis.
    - b. Sensitivity: 96 dB.
    - c. Power Handling Capacity: 40 watts.
    - d. Voice Coil Impedance: 8 ohms.
    - e. Transformer Taps: 2.5, 5, 10 watts.
  3. Acceptable Products:
    - a. JBL LCT 81C/T.
    - b. Approved equal.
- E. Gymnasium Speakers
1. Features:
    - a. 2-way, full range.
    - b. Symmetrical trapezoidal enclosure.
    - c. LF subsystem & loading: 1x 8".
    - d. HF subsystem & loading: 1x25mm.
  2. Minimum Performance Requirements:
    - a. Frequency Response: -3 dB, 100-20,000 Hz.
    - b. Frequency Response: -10 dB, 80-18,000 Hz.

- c. Axial Sensitivity (dB SPL, 1 Watt @ 1m): 94dB.
    - d. Nominal Impedance: 8 Ohms.
    - e. Power Handling (IEC Standard): 200 watts.
    - f. Maximum Output (dB SPL @ 1m): 118 dB.
    - g. Nominal Coverage Angle: 120° x 120°.
  3. Acceptable Products:
    - a. JBL AWC82 with transformer and mounting hardware as required. Finish for loudspeaker and mounting hardware to be approved by Architect.
    - b. Community Loudspeaker R.25 with transformer and mounting hardware as required. Finish for loudspeaker and mounting hardware to be approved by Architect.
    - c. Approved equal.
- F. Headphones
  1. Dynamic stereo headphones with supraural ear pads.
  2. Features:
    - a. Nominal Impedance: 600 ohms.
    - b. Sensitivity: 0.77V (1 mW) for 94.3 dB SPL.
    - c. Maximum Continuous Input: 11V (200 mW).
    - d. Weight: 7.9 ounces without cable.
  3. Acceptable Products:
    - a. AKG K-240 MKII.
    - b. Sennheiser HD 280.
    - c. Beyerdynamic DT 990 PRO.
    - d. Approved equal.
- G. Powered Stage Monitor
  1. Self-amplified loudspeaker system includes a 12" woofer and an extended range 1.5" HF driver coupled to high frequency horn.
  2. Minimum Performance Requirements:
    - a. Frequency Range (-3 dB): 65 to 18,000 Hz.
    - b. Nominal Dispersion: 90°x60°
    - c. Maximum SPL Output: 126 dB peak.
    - d. Power Rating: 1000W.
    - e. Input Connectors: 2 x Balanced XLR/1/4 inch input, 1 x 3.5mm.
  3. Provide with stand and cable
  4. Acceptable Products:
    - a. JBL PRX412M with tripod.
    - b. Electro-Voice ZLX-12P with tripod.
    - c. EAW LA212 with tripod
    - d. Approved equal.
- H. Surface Mount Loudspeaker (Cafeteria)
  1. Two-way loudspeaker containing separate 5.25" low-frequency driver and 0.75" horn-loaded high-frequency driver and a passive cross-over network.
  2. Adjustable single-point wall-mount with multiple axis rotation, multi-point wall-mount, available with optional U-bracket.
  3. Minimum Performance Requirements:
    - a. Frequency Response: 70-23,000 Hz, -10 dB.
    - b. Nominal Impedance: 8 ohms.
    - c. Sensitivity: 87 dB 1W/1m.
    - d. Power Handling Capacity: 200 watts continuous program.

4. Acceptable Products:
  - a. JBL Control 25 with mounting hardware, color as approved by Architect.
  - b. Atlas Sound SM63T with mounting hardware, color as approved by Architect.
  - c. Approved equal.
  
- I. Wall Mount Loudspeaker (Band/Chorus)
  1. 2-way full-range loudspeaker system comprised of one 258 mm low frequency driver and one 25 mm exit/35 mm voice-coil compression driver.
  2. Minimum Performance Requirements:
    - a. Frequency Response: 68-23,000 Hz, -10 dB.
    - b. Nominal Impedance: 8 ohms.
    - c. Max SPL: 118 dB peak.
    - d. Sensitivity: 95 dB 1W/1m.
    - e. Power Handling Capacity: 400 watts program.
  3. Acceptable Products:
    - a. JBL AC195 with wall mount hardware.
    - b. Renkus Heinz CX82 with wall mount hardware
    - c. Approved equal.

## 2.06 ASSISTIVE LISTENING

- A. General: Locate antenna for ALS no farther than 200 feet from transmitter. Coordinate location of antenna with Owner, Architect, and Electrical Contractor.
  
- B. Provide with the sufficient receivers to meet the 2010 ADA standards with 25% of the receivers to be hearing-aid compatible
  
- C. Assistive Listening Transmitter:
  1. Features:
    - a. Operates on 72MHz.
    - b. LED indicators for audio level, RF modulation, and RF output power.
    - c. Tunable to 57 wide and narrow band channels.
  2. Minimum Performance Requirements:
    - a. RF Frequency Range: 72.025 – 75.950 MHz.
    - b. Transmitter Stability: 50PPM.
    - c. Output Power: 100mW.
    - d. Signal to Noise: 44dB.
  3. Acceptable Products:
    - a. Listen Technologies LT-800 72 MHz base unit with power supply, & rack mount kit.
    - b. William Sound equivalent.
    - c. Approved equal.
  
- D. ALS Antenna:
  1. Acceptable Products:
    - a. LA-122 Antenna kit, provided with RG-8/U cable as required.
    - b. William Sound equivalent.
    - c. Approved equal.
  
- E. Receiver:
  1. Features:
  2. 17 channel digital receiver.

3. LED indicators.
  4. Minimum Performance Requirements:
    - a. RF Frequency Range: 72.025 – 75.950MHz.
    - b. Sensitivity: .6uV typical, 1uV maximum for 12dB SINAD.
    - c. Signal to Noise: 80dB.
  5. Acceptable Products:
    - a. Listen Technologies LR-4200-P1 receiver package with neck loop and ear speaker.
    - b. William Sound equivalent.
    - c. Approved equal.
- F. Charging Station:
1. Features:
    - a. 12-unit charging tray.
  2. Acceptable Products:
    - a. Listen Technologies LA-381-01. Provide charging stations to charge all receivers simultaneously.
    - b. William Sound equivalent.
    - c. Approved equal.

## 2.07 PRODUCTION COMMUNICATIONS

- A. General
1. Full-duplex, wired communication system with multiple, independent channels, master control station, and various types of remote headset and loudspeaker stations.
  2. System Performance Requirements:
  3. Frequency Response: 250-8,000 Hz  $\pm$ 3 dB, worst case.
  4. Signal-to-Noise Ratio: 60 dB.
  5. Headphone Outputs: 200-1,000 ohm load, capable of driving headphones to min. 100 dB SPL.
  6. Mic Inputs: Nominal 200 ohm source.
  7. Operating Voltage: 24 to 28 VDC, nominal.
- B. Production Communication Master Station
1. Features:
    - a. 2-Channel Headset/Speaker Main Station with Built-in 2-amp Power Supply, Rack Mount (1RU)
    - b. Two intercom channels with programmable front-panel buttons.
    - c. High-capacity, fail-safe power supply supports up to 40 beltpacks or 10 speaker stations or 12 headset stations; 3 IFB channels, announce button/relay, channel-linking button and Remote Mic Kill switch.
    - d. All Channel linking
    - e. Program input with individual channel level controls
    - f. Remote Mic Kill switch
    - g. Stage Announce
  2. Acceptable Products:
    - a. Clear-Com MS-702. Provide with compatible gooseneck microphone.
    - b. Telex equivalent.
    - c. Approved equal.
- C. Power Supply
1. Acceptable Products:



- a. Clear-Com PK-7.
  - b. Telex equivalent.
  - c. Approved equal.
- D. Prod Comm. Paging Station
- 1. Wall mounted paging station.
  - 2. Two channel party-line wall station.
  - 3. Features:
    - a. Production communications belt-pack receptacle.
    - b. Integrated speaker.
  - 4. Acceptable Products:
    - a. Clear-Com KB-702.
    - b. Telex equivalent.
    - c. Approved equal.
- E. Prod. Comm. Station with Gooseneck Microphone in Desktop Enclosure
- 1. Desktop paging station.
  - 2. Two channel party-line.
  - 3. Features:
    - a. Production communications belt-pack receptacle.
    - b. Integrated speaker.
    - c. Provide with angled desktop enclosure and gooseneck microphone.
  - 4. Acceptable Products:
    - a. Clear-Com KB-702GM with V-BOX enclosure and gooseneck microphone.
    - b. Telex equivalent.
    - c. Approved equal.
- F. Production Communications Belt-Pack Unit
- 1. Belt-mounted headset station with mic on/off switch, call switch and indicator, headset receptacle, headset volume control, adjustable side tone, and extension connector for additional belt-pack units.
  - 2. Single Channel Belt Pack
    - a. 1-Channel.
    - b. Acceptable Products:
      - 1) Clear-Com RS-701.
      - 2) Telex equivalent.
      - 3) Approved equal.
  - 3. Dual-Channel Belt Pack
    - a. Acceptable Products:
      - 1) Clear-Com RS-702.
      - 2) Telex equivalent.
      - 3) Approved equal..
- G. Prod Comm. Headset
- 1. Headset with earphone(s), noise-canceling boom microphone and min. 5 ft coiled cord terminated with connector compatible with Belt-Pack Units.
  - 2. Single-Muff Headset
    - a. Acceptable Products:
      - 1) Clear-Com CC-300 Single Muff.
      - 2) Telex equivalent.
      - 3) Approved equal.

3. Double-Muff Headset:
  - a. Acceptable Products:
    - 1) Clear-Com CC-400 Double Muff.
    - 2) Telex equivalent.
    - 3) Approved equal.

## 2.08 VIDEO SOURCE EQUIPMENT

- A. Blu-ray Player
  1. High-definition DVD player compatible with Blu-ray, standard DVD, and Audio CD discs.
  2. Features:
    - a. Maximum output resolution: 1080p/24.
    - b. HDMI video output capable of 1080i resolution.
    - c. Stereo analog output
    - d. Streaming video via BD Live.
    - e. HDMI v1.4 compatible.
    - f. RS-232C control.
    - g. Hand-held wireless remote control.
  3. Acceptable Products:
    - a. Denon DN-500BD.
    - b. Sony UBP-X1000ES.
    - c. Approved equal.
- B. BYOD Receiver
  1. Video source allowing wireless presentation of laptops, tablets, and smart phones.
  2. Features:
    - a. Fully managed over the network using SNMP.
    - b. Wireless: Dual band, 802.11n 2x2 Mimo WiFi.
    - c. OS support: Windows, OSX and Android.
    - d. Output format: HDMI 1.4 output with Audio.
    - e. Remotely managed and configured using any web browser.
    - f. Streaming video support: 4K resolution (3840 x 2160), HD (1920x1080), HD SD (1280x720).
  3. Acceptable Products:
    - a. Mersive Solstice Pod Enterprise Unlimited with mounting accessories, as required.
    - b. Crestron Airmidia equivalent.
    - c. Approved equal.
- C. HD Video Recorder
  1. Features:
    - a. Video
      - 1) HDMI and HD-SDI video input
      - 2) Resolutions up to 1080p
    - b. Audio
      - 1) Balanced inputs
      - 2) Recording
      - 3) Codec support: Uncompressed QuickTime, Apple ProRes 422 (HQ) QuickTime, ProRes 422 QuickTime, ProRes 422 (LT) QuickTime, ProRes 422 (Proxy) QuickTime, Avid DNxHD.QuickTime, Avid DNxHD MXF.
      - 4) Timecode in/out.
  2. Acceptable Products

- 
- a. Black Magic HyperDeck Studio Pro with (2) San Disk Extreme II 480GB solid state plug-in drives and Cable Matters (or equal SATA reader) SATA SSD external reader.
  - b. Approved Equal
- D. PTZ Video Camera
- 1. Full HD PTZ camera w/ HD-SDI output.
  - 2. Minimum Performance Requirements:
    - a. Imaging Sensor: 1/2.3 type Full-HD MOS.
    - b. Lens: Motorized 30x zoom, f1.6 to 4.7.
    - c. Focus: Auto/Manual switchable.
    - d. Output Format: HD: 1080/59.94i, 720/59.94p
    - e. Video Output: SDI.
    - f. IP video with up to 5 terminals.
    - g. Control: RS-422 or IP.
    - h. Rotation Range: Pan:  $\pm 175^\circ$ , Tilt:  $+90^\circ$  to  $-30^\circ$ .
  - 3. Acceptable Products:
    - a. Panasonic AW-HE40S with wall mount hardware, color to be approved by Architect.
    - b. Sony SRG-300SE with wall mount hardware, color to be approved by Architect.
    - c. Approved equal.

## 2.09 VIDEO ROUTING AND PROCESSING

- A. The functional diagram(s) connections shown on the bid documents are based on components manufactured by Crestron. This manufacturer was used only as a reference to show the signal flow for the completed audiovisual system. Extron and AMX are approved equals. The contractor must supply any additional equipment required to provide a complete audiovisual system.
- B. 10x8 Digital Video Switcher
  - 1. 10 x 8 digital video matrix switcher with scaler and audio DSP.
  - 2. Features:
    - a. (6) HDMI, 4 DTP twisted pair, 6 balanced or unbalanced audio inputs, 4 microphone inputs.
    - b. (4) HDMI, (4) HDMI/TP output, 4 stereo Line audio.
    - c. EDID minder.
    - d. Integrated audio digital signal processor.
    - e. HDMI embed and de-embedding of audio.
    - f. HDMI to DVI Interface Format Correction: Automatically enables or disables embedded audio and InfoFrames, and sets the correct color space for proper connection to HDMI and DVI displays.
    - g. Ethernet monitoring and control.
    - h. RS-232 control.
    - i. Two independently scaled DTP outputs.
  - 3. Minimum Performance Requirements:
    - a. Maximum data rate: 10.2 Gbps (3.4 Gbps per color).
    - b. Audio Inputs: Balanced, +4 dBu.
    - c. Video: HDCP, Resolutions up to 4096 x 2160 up to 60 Hz or 4K.
    - d. Standards: DVI 1.0, HDMI 1.4, HDCP 1.4, CEA-861E.
  - 4. Acceptable Products:
    - a. Extron DTP CrossPoint 108 4K.
    - b. Approved equal.

- C. HDMI Extender
  - 1. HDMI input jack.
  - 2. Supports computer resolutions up to 4K.
  - 3. Analog 3.5 mm audio input.
  - 4. HDCP compliant.
  - 5. Signal transmission distance (1080p @ 60 Hz): Up to 330' (70 m) using shielded twisted pair (STP) cable or XTP DTP 24 STP cable.
  - 6. Acceptable Products
    - a. DTP T HWP 4K 232 D, coordinate color with Architect.
    - b. DTP T FB 232
    - c. DTP T HWP 4K 231 D, coordinate color with Architect.
    - d. DTP HDMI 4K 230 Tx
    - e. Extron DTP T HWP 4K 331 D, coordinate color with Architect.
    - f. Extron DTP HDMI 4K 330 Tx.
    - g. Approved equal.
  
- D. HDMI Receiver
  - 1. Standalone Digital Video receiver with HDMI output.
  - 2. Supports computer resolutions up to 4K.
  - 3. Bidirectional RS-232 for device control.
  - 4. HDCP and EDID support.
  - 5. Acceptable Products:
    - a. Extron DTP HDMI 4K 330 Rx.
    - b. Approved equal.
  
- E. Digital Video Distribution Amplifier
  - 1. Video distribution amplifier with video over twisted pair outputs.
  - 2. Supports computer resolutions up to 4K.
  - 3. Acceptable Products:
    - a. Extron DTP HD DA4 4K 230
    - b. Extron DTP HD DA8 4K 230
    - c. Approved equal
  
- F. HDMI Extender
  - 1. Acceptable Products
    - a. Extron DTP transmitters as required,
      - 1) DTP T HWP 4K 232 D
      - 2) DTP T FB 232
      - 3) DTP T HWP 4K 231 D
      - 4) DTP HDMI 4K 230 Tx
    - b. Approved equal
  
- G. SDI to HDMI Converter
  - 1. Features:
    - a. 3G-SDI, HD-SDI, and SDI to HDMI video scaling.
    - b. Output: One HDMI.
    - c. Inputs: One 3G-SDI/HD-SDI/SDI with buffered input loop-through on BNC connectors.
  - 2. Acceptable Products:
    - a. AJA Hi5-Plus with mounting hardware.
    - b. Extron DSC 3G-HD A with mounting hardware.

- c. Black Magic Mini Converter SDI to HDMI 6G with mounting hardware.
- d. Approved equal.

## 2.10 VIDEO DISPLAYS

### A. 22" Monitor

- 1. Features:
  - a. VESA mount compatible.
  - b. 1920 x 1080 resolution.
  - c. Brightness: 250 cd/m<sup>2</sup>.
  - d. Connectors: D-Sub, HDMI.
  - e. Panel: IPS.
- 2. Acceptable Products:
  - a. LG Electronics 22MC57HQ-P.
  - b. Dell P2217H.
  - c. ViewSonic VA2256-MHD.
  - d. Approved equal.

### B. Flat Panel Display, 70"

- 1. General: 70" class high definition LCD panel with LED backlight.
- 2. Minimum Performance Requirements:
  - a. Resolution: 3840x2160 pixels
  - b. Backlight: LED
  - c. Inputs: (2) HDMI, (1) Audio L/R in, line level audio output.
  - d. Thickness: 2.39"
  - e. Bi-directional RS-232 control capability.
  - f. Brightness: 500 cd/m<sup>2</sup>
- 3. Acceptable Products:
  - a. LG 75UMC3C with Chief MFG. wall mount. Provide with Owner approved locking hardware.
  - b. Sharp PN-H701 with Chief wall mount. Provide with Owner approved locking hardware.
  - c. NEC P series with low profile mount. Provide with Owner approved locking hardware.
  - d. Approved equal.

### C. Video Projector Type 1 (Auditorium & Gymnasium)

- 1. Wide-screen color LCD video projector.
- 2. Features:
  - a. HDMI, DVI-D, 15 pin D-sub. Discrete Input Selection.
  - b. RS-232 remote control and wireless remote control unit for presentation and set-up.
- 3. Minimum Performance Requirements:
  - a. 12,000 ANSI lumens, laser light source, 34dB fan noise.
  - b. 15,000:1 contrast ratio.
  - c. 1920 x 1200 native panel resolution.
  - d. Compatibility with HDTV sources include 480i, 480p, 576i, 576p, 720p, 1080i, 1080p.
  - e. Vertical and horizontal lens shift.
  - f. Network and RS-232 control ports.
  - g. 20,000 hour lamp life.
- 4. Acceptable Products:
  - a. Epson L1505U with appropriate zoom lens and mount.
  - b. Sony VPL-FHZ120L with appropriate zoom lens and mount.

- c. Panasonic PT-RZ120 with appropriate zoom lens and mount.
- d. Approved equal.

## 2.11 CONTROL SYSTEMS

- A. Custom Audiovisual Control System Software/Programming:
  - 1. Custom software and programming for AV control system control panels and mainframes to provide control of AV devices and user-friendly control interface.
  - 2. Programming provided by a programming service company engaged in providing such services to third parties as a principal business activity.
  - 3. Product to be developed using AV control system manufacturer's programming tools and to include touch panel layouts, programming source and compiled code, and written documentation. Product to exploit full graphical capabilities of control system hardware and maximum available feedback of controlled equipment.
  - 4. Control functions as itemized in parts 1 and 3 of the audiovisual specification and on the contract drawings.
  - 5. Product shall conform project standards, including colors, logos, etc.
  - 6. Acceptable Products:
    - a. Custom software and documentation from certified in-house programming staff or other sub-contractor as approved according to Division 1. Provide touchpanel layouts as required under Part 1.6 - Submittals.
  
- B. 10" Tabletop Touch Panel
  - 1. A 10" LCD panel with touch sensitive screen.
  - 2. Features:
    - a. Color touch-panel.
    - b. Touchscreen:
      - 1) Display Type: TFT active matrix color LCD.
      - 2) Screen Dimensions: 10" diagonal.
      - 3) Resolution: 1280x800 pixels.
      - 4) Contrast: 950:1
    - c. Communications protocol compatible with respective integrated control system.
    - d. Communications:
      - 1) 10/100 Mbps Ethernet with LAN PoE.
  - 3. Acceptable Products:
    - a. Crestron TSW-1060 with TSW-1060-TTK table top kit, color as approved by Architect.
    - b. AMX equivalent.
    - c. Approved equal.
  
- C. 10" Wall Mounted Touch Panel
  - 1. A 10" LCD panel with touch sensitive screen.
  - 2. Features:
    - a. Color touch-panel.
    - b. Touchscreen:
      - 1) Display Type: TFT active matrix color LCD.
      - 2) Screen Dimensions: 10" diagonal.
      - 3) Resolution: 1280x800 pixels.
      - 4) Contrast: 950:1
    - c. Communications protocol compatible with respective integrated control system.
    - d. Communications:
      - 1) 10/100 Mbps Ethernet with LAN PoE.

3. Acceptable Products:
  - a. Crestron TSW-1060, color as approved by Architect.
  - b. AMX equivalent.
  - c. Approved equal.
  
- D. AV Control System Type 1
  1. Fully integrated, programmable system for control of audiovisual system equipment and other motorized, electronic or electrical devices that can be remote controlled.
  2. Features:
    - a. Supports 4-wire control network operation for interfacing with outboard, remote devices including control modules and control panels.
    - b. Supports 8-wire LAN/Ethernet expansion of the control network.
    - c. Programmable with high level language via external PC or Apple computer (computer not provided.)
    - d. Rack mountable.
  3. Control Ports:
    - a. Ethernet: 8-wire RJ-type connector.
    - b. Relays: (8) normally opened, isolated relays rated at 1A, 30VAC/DC.
    - c. Input/Output: (8) programmable input and digital outputs.
    - d. IR/Serial: (8) serial outputs for IR, or serial interface.
    - e. COM: (3) bidirectional serial ports for RS-232, RS-422 or RS-485 communication.
    - f. Net: (1) 4-pin male connector for control network.
    - g. Listing below indicates the basis of the system. The contractor is responsible to review this configuration and supply all programming and any additional components required to make a fully-functional system.
  4. Acceptable Products:
    - a. Crestron 3-Series System with the following Components
      - 1) CP3N control processor with CEN-IO-COM-102 COM port modules.
      - 2) Power supplies, cables, and miscellaneous accessories as required.
    - b. AMX equivalent.
    - c. Approved equal.

## 2.12 NETWORK

- A. 16-Port PoE Switch
  1. Features:
    - a. Connectors: (16) RJ-45.
    - b. Network Standards: IEEE 802.3, 802.3u, 802.3ab, 802.3bc, 802.3af, 802.3at Type 1 and 2.
    - c. Data Rate: 10/100/1000Base-T auto-sensing Gigabit Ethernet.
    - d. Supports IEEE 802.3at Type 2 PoE+, Class 4 (34.2W) power sourcing from any ports up to the maximum specified power capabilities; Maximum 34.2 Watts per port, 255 Watts total.
  2. Acceptable Products:
    - a. Crestron CEN-SWPOE-16.
    - b. Cisco equivalent
    - c. Approved equal.
  
- B. Audio Network Switch (Dante)
  1. Network switch configured and optimized for digital audio.
  2. Features:

- a. EtherCON Connectors: 4 front / 4 rear.
  - b. LAN ports (1000BASE-T/100BASE-TX/10BASE-T/etherCON connector): 8.
  - c. Support functions: Storm control, HOL blocking prevention, Loop detection, ACL, SNMP agents, Link aggregation (IEEE 802.3ad LACP, Static), Spanning tree (STP\*, RSTP\*, MSTP), Port mirroring, Port shutdown, Link speed down shift, Packet counter, Power saving mode (IEEE802.3az EEE; Disabled in DANTE mode), DHCP client, Logging, Firmware download via TFTP/HTTP, Config file download via TFTP \*STP and RSTP are supported via downward compatibility of MSTP.
  - d. QoS: 8 egress queues, Policy-based QoS, Remarking (CoS, ToS, DSCP), Scheduling (SP, WRR).
  - e. Throughput: 15 Mpps.
3. Acceptable Products:
    - a. Yamaha SWP1-8.
    - b. Luminex GigaCore 12.
    - c. Approved equal.
- C. Network Patch Panel
- D. PoE Injector:
1. PoE injector for AV equipment.
  2. Features:
    - a. Connectors: RJ-45.
    - b. 802.3af compliant.
    - c. 350 mA maximum @ 48 Volts DC nominal.
  3. Acceptable Products:
    - a. Crestron PWE-4803RU.
    - b. Approved equal.

## 2.13 RACKS, CARTS, FURNITURE, AND MOUNTS

- A. Custom Loudspeaker Rigging Hardware
1. Acceptable Products:
    - a. Adaptive Group.
    - b. Polar Focus.
    - c. Approved equal.
- B. Projector Mount
1. UL listed.
  2. Weight Capacity 250 lbs.
  3. Roll: 5°, Pitch: 20°, Yaw: 360°.
  4. Acceptable Products:
    - a. Legrand/Chief VCMU.
    - b. Approved equal.
- C. Equipment Rack General:
1. VERIFY ALL RACK SIZES, TYPES AND FINISHES WITH ARCHITECT OR PROJECT MANAGER BEFORE ORDERING.
  2. VERIFY AND COORDINATE ALL BLOCKING AND CLEARANCE REQUIREMENTS BEFORE ORDERING.



3. Equipment rack for standard 19" wide panels. Minimum 16 gauge cold rolled steel construction with louvered sides. Mounting rails with tapped 10-32 threaded holes on EIA spacing. Welded construction.
  4. Power for all rack equipment controlled by single master switch.
  5. Finish as approved by architect.
  6. Vent panels, blank panels and rack mount shelves as shown on drawings.
  7. Provide shelves and rack mount hardware as required.
  8. Cabling to be supported by lacing bars.
- D. Equipment Rack
1. Welded floor rack assembly provided with side panels, lockable rear door and adjustable rear mounting rails, lacing bars and power distribution.
  2. Features:
    - a. Height as indicated or required
    - b. Power for all rack equipment controlled by single master switch/power sequencer and vertical AC power raceway.
    - c. Vent panels, blank panels and rack mount shelves as shown on drawings.
    - d. Provide top panel with temperature controlled fan unit.
  3. Provide caster bases and casters where necessary for service access
  4. Acceptable Products:
    - a. Middle Atlantic Products ERK-4425 with rear rack rails, AC power distribution, vented top panel with temperature controlled fan unit, and locking doors, and caster base. Equipment rack for Gymnasium to be ERK-35-20 with accessories as listed above.
    - b. Lowell equivalent.
    - c. Atlas Sound equivalent.
    - d. Approved equal.
- E. Equipment Rack (Band and Chorus)
1. Mobile presentation furniture rack.
  2. Features:
    - a. Bolt-through casters (3") and internal steel bracing.
    - b. Locking glass front door is standard.
  3. Acceptable Products:
    - a. Middle Atlantic Products RFR series RFR-1628BR, finish to be approved by Architect.
    - b. Approved equal.
- F. Portable Equipment Rack (for digital stage box)
1. Rack mount case for portable equipment.
  2. Acceptable Products:
    - a. Gator GR Deluxe rack case.
    - b. SKB Roto Rack case.
    - c. Pelican Hardigg.
    - d. Approved equal.
- G. Power Conditioner with Lights
1. Rack-mounted sequential power controller with front panel power switch and lights.
  2. Features:
    - a. 8 rear panel outlets, 1 front panel outlet.
    - b. 15 amp rating with circuit breaker.
    - c. Noise filtration and surge protection.
  3. Acceptable Products:

- a. Furman M-8Dx.
  - b. Middle Atlantic equivalent.
  - c. SurgeX equivalent.
  - d. Approved equal.
- H. Power Sequencer
- 1. Rack-mounted sequential power controller providing time-sequenced activation and de-activation of equipment with integrated system power switch.
  - 2. Features:
    - a. Front panel actuation switch.
    - b. Alarm interface.
    - c. Four (minimum) sequencing steps.
    - d. Front AC outlet.
    - e. LED status indicator.
    - f. 20A, 9 outlet.
  - 3. Acceptable Products:
    - a. Lowell ACR-SEQ6-2009.
    - b. Middle Atlantic equivalent.
    - c. SurgeX equivalent.
    - d. Equivalent.
- I. AC Receptacle(s) & Raceway:
- 1. AC power receptacles for power distribution in equipment racks and cabinets.
  - 2. Features:
    - a. Compatible with power sequencer for remote control of AC outlet raceway.
    - b. UL Recognized
    - c. Multiple circuit strip.
    - d. 20 Amp power rating.
    - e. Isolated Ground.
  - 3. Acceptable Products:
    - a. Middle Atlantic MPR series, as required. Provide with compatible 20A remote controlled power raceway, as required.
    - b. Lowell POWERSTAC Series, as required. Provide with compatible 20A remote controlled power raceway, as required.
    - c. Equivalent.
- J. Rack Hardware and Panels:
- 1. Blank Panels:
    - a. 16-gauge flanged solid steel with black smooth ended for or textured enamel finish.
    - b. Acceptable Products:
      - 1) Middle Atlantic SB series.
      - 2) Atlas Sound S19 series.
      - 3) Lowell AFP series.
      - 4) Approved equal.
  - 2. Vent Panels:
    - a. 16-gauge flanged perforated steel with black smooth or textured enamel finish.
    - b. Acceptable Products:
      - 1) Middle Atlantic VTF series.
      - 2) Atlas Sound SVP19 series.
      - 3) Lowell SVP series.

- 4) Approved equal.
- 3. Rack Drawer:
  - a. Lockable rack mount heavy-duty drawer with spring latch to keep drawer closed.
  - b. Acceptable Products:
    - 1) Middle Atlantic D series drawers. Size as indicated on drawings.
    - 2) Atlas Sound SD series, size as indicated on contract drawings.
    - 3) Lowell UDE series, size as indicated on contract drawings.
    - 4) Approved equal.
- 4. Pull Out Rack Shelf:
  - a. General: Slide out rack-shelf for support of portable equipment, capable of latching in open position.
  - b. Acceptable Products:
    - 1) Middle Atlantic SS.
    - 2) Lowell SLS.
    - 3) Approved equal.
- 5. Fixed Rack Shelf:
  - a. General: Universal rack-shelf for non-rack mount equipment.
  - b. Acceptable Products:
    - 1) Middle Atlantic U1.
    - 2) Middle Atlantic WUSS15.5
    - 3) Atlas Sound SH1-10.
    - 4) Lowell US-110.
    - 5) Approved equal.

2.14 MISCELLANEOUS

- A. 8x4 Stage Box
  - 1. 8 XLR-F microphone inputs.
  - 2. 4 XLR-M line returns.
  - 3. 50'-0" cable.
  - 4. Multipin output connector compatible with multi-pair receptacle input.
  - 5. Acceptable Products:
    - a. Whirlwind custom 8x4 stage box assembly.
    - b. Approved equal.
- B. Auditorium Video Projector ISO Box
  - 1. Acoustic enclosure for video projector.
  - 2. Acceptable Products:
    - a. Whisper 100 projector enclosure. Coordinate finish with Architect.
    - b. Draper equivalent. Coordinate finish with Architect.
    - c. Approved equal

2.15 CABLING

- A. The following tables list the cabling and connectors that have been approved for the project. This is not an all-inclusive list of the cabling required to complete the installation and fabrication of the audiovisual systems. The contractor may submit cable part numbers, models, and product data for cable that is not listed in the table for approval by the consultant.

Application	Description	Manufacturer	Model No.	Comments
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Audio				
Microphone	22 AWG STP	West Penn Belden Liberty	291 8761 22-2C-SH-GRY	Equal
Microphone/Line Level (Plenum)	22 AWG STP	West Penn Belden Liberty	25291 88761, 87761 22-2C-PSH-WHT	Equal
Line Level	20 AWG STP	West Penn Belden Liberty	292 8762 20-2C-SH-GRY	Equal
Intercom	20 AWG STP	West Penn Belden Liberty	292 8762 20-2C-SH-GRY	Equal
Speaker Low Z - Mains and Subwoofers	10 AWG UTP	West Penn	HA210	Equal
Speaker Mains	12 AWG UTP	West Penn Belden Liberty	227 8477 10-2C-GRY	Equal
Speaker Mains (Plenum)	12 AWG UTP	West Penn Extron Liberty	25227 SPK-14 12-2C-P-WHT	Equal
Speaker General Purpose	14 AWG UTP	West Penn Belden Liberty	226 8473 14-2C-GRY	Equal
Speaker General Purpose (Plenum)	14 AWG UTP	West Penn Extron Liberty	25226 SPK-14 Plenum 14-2C-P-WHT	Equal
Speaker General Purpose	16 AWG UTP	West Penn Belden Liberty	225 8471 16-2C-GRY	Equal
Speaker General Purpose (Plenum)	16 AWG UTP	West Penn Extron Liberty	25225 SPK-16 Plenum 16-2C-P-WHT	Equal
Speaker General Purpose	18 AWG UTP	West Penn Belden Liberty	224 8461 18-2C-GRY	Equal
Speaker General Purpose (Plenum)	18 AWG UTP	West Penn Extron Liberty Belden	25224 SPK-18 Plenum 18-wC-P-WHT 89740	Equal
Video				
Hybrid Broadcast	2-Single Mode 9μ Mode Field 125μ Cladding 2-24 AWG UTP 4-20 AWG UTP 1-16 AWG Steel	Gepco Belden	HDC920 7804Ex	Equal

Precision Video	75 Ohm Coax RG-6U	West Penn Belden Alpha	6350 1694A 6458	Equal
Precision Video	75 Ohm Coax RG-59U	West Penn Belden Alpha	819 8241 9102	Equal
Video In Rack	75 Ohm Coax RG-59U	West Penn Belden Alpha	819 8241 9102	Equal
CATV Trunk Lines	75 Ohm Coax RG-11/U	West Penn Belden Liberty	821 9064 RG11-CATV-BLK	Equal
CATV Trunk Lines (Plenum)	75 Ohm Coax RG-11/U	West Penn Liberty	25821 RG11-P-CATV-WHT	Equal
Control and Data				
ALS Antenna	50 Ohm Coax RG-8U	West Penn Belden Liberty	810 7733A RG8-CMP-BLK	Equal
Category 5e	23 AWG UTP	West Penn Belden Liberty	4245 DataTwist 1200 24-4P-L5-EN	Equal
Category 6	23 AWG UTP	West Penn Belden Liberty	4246 DataTwist 2400 24-4P-L6	Equal
Category 6 (Plenum)	24 AWG UTP	Belden Liberty	DataTwist 7882A 24-4P-P-L6	Equal
RS232/422	24 AWG STP	West Penn Belden Black Box	D2404 9925 Series Extended Distance Data Cable	Equal
Crestnet/AXLink	2-18 AWG UTP with 2-22 AWG STP	West Penn Liberty Crestron	77350 Cresnet/AXLINK CRESNET-NP	Equal
Crestron/AXLINK (Plenum)	2-18 AWG UTP with 2-22 AWG STP	Liberty	Cresnet-P AXLINK-P	Equal
Crestron DigitalMedia	4 pr 24AWG STP (shielded)	Crestron	DM-CBL-3G-NP	No Equal
Crestron Fiber Optic DigitalMedia	OM3 Type 50/125um x 4 Multimode Fiber	Crestron	CRESFIBER8G-NP	No Equal
Extron XTP DTP	4 pr 24AWG STP (shielded)	Extron	XTP DTP 24/1000	No Equal
Extron Fiber Optic XTP	OM4 Type 50/125um x2 Multimode Fiber	Extron	OM4 MM P	No Equal
Interface Cables				

HDMI Interface Cable	High-speed Category 2 HDMI Cable w/locking connectors	Crestron Perfect Path	CBL-HD-LOCK 700 Series	Equal
DVI Interface Cable	Dual Link DVI-D	Crestron	CBL-DVI	Equal
Display Port	DisplayPort 1.2 cable 25'	Extron	26-657-25	Equal
25' Microphone, Line, and Intercom	22 AWG STP	Whirlwind Wireworks	WMKPVC-25 C-25	Equal
50' Microphone and Intercom	22 AWG STP	Whirlwind Wireworks	WMKPVC-50 C-50	Equal
25' Monitor Speaker	12 AWG UTP	Whirlwind Pro Co	SK525G12 S12NN-25	Equal
Mult-pin to Fan-Out	12 Pair Multi-conductor 23 AWG STP	Whirlwind	FM120NRW11F12	Equal

2.16 APPROVED CONNECTORS

- A. Connectors listed below are suggested for use with the specified cabling. The list may not include all of the connectors required to complete the installation of the systems. If a different cable is submitted for approval by the consultant, provide the appropriate connector for the cable as part of the cable submission.

Application	Description	Manufacturer	Model No.	Comments
Audio				
Mic/Line/Intercom	XLR Male Panel Mount	Neutrik Switchcraft	NC3MX A3M	Equal
Mic/Line/Intercom	XLR Female Panel Mount	Neutrik Switchcraft	NC3FD D3F	Equal
Combo Line	XLR plus 1/4" Phone Panel Mount	Neutrik	NCJ5FI-S	Equal
Mic/Line/Intercom	XLR Male Inline Cable	Neutrik Switchcraft	NC3MD A3M	Equal
Mic/Line/Intercom	XLR Female Inline Cable	Neutrik Switchcraft	NC3FD A3F	Equal
Mic/Line Multipin	12 Pair Female Panel Mount	Whirlwind	W1CM	Equal
Mic/Line Multipin	12 Pair Male Inline Cable	Whirlwind	W1IM	Equal
Mic Broadcast	DT-12 Male Inline Cable	Whirlwind	DT12IM	Equal
Mic Broadcast	DT-12 Female Panel Mount	Whirlwind	DT12CF	Equal

Speaker	4-Pole Panel Mount	Neutrik	NL4MP	Equal
Speaker	8-Pole Panel Mount	Neutrik	NL8MPR	Equal
Speaker	4-Pole Inline Cable	Neutrik	NL4FC	Equal
Speaker	8-Pole Inline Cable	Neutrik	NL8FC	Equal
Video				
Hybrid Broadcast	Hybrid Panel Mount Male	Lemo	FMW.3K.93C.TLMC96Z	Equal
Hybrid Broadcast	Hybrid Panel Mount Female	Lemo	PEW.3K.93C.TLCC96Z	Equal
Precision Video	75 Ohm Panel Mount	Neutrik Trompeter Kings	NBB75DFG UBJ28 KC-99-54	Equal
Precision Video	75 Ohm Inline Cable RG-6	Neutrik Trompeter Kings	NBNC75BTU11 UPL2000 Series 2065-10-9	Equal
Precision Video	75 Ohm Inline Cable RG-59	Neutrik Trompeter Kings	NBNC75BLP9 UPL-220-014 or -023 2025-51-9 or 2025-53-9	Equal
Recessed Video Receptacle	75 Ohm Pass-Thru	Canare	BCJ-JRU	Equal
Control and Data				
50 Ohm ALS Ant.	50 Ohm BNC Cable Mount	West Penn	CN-BM53-13	Equal
Ruggedized RJ-45 Cat 5 Receptacle	Ruggedized RJ-45 Panel Mount	Neutrik	NE8FDV-YK-B	Equal
Ruggedized RJ-45 Cat 5 Connector	Ruggedized RJ-45 Inline Cable	Neutrik	NE8MC-1	Equal
Ruggedized RJ-45 Cat 6 Receptacle	Ruggedized RJ-45 Panel Mount	Neutrik	NE8FDY-C6-B	Equal
Ruggedized RJ-45 Cat 6 Connector	Ruggedized RJ-45 Inline Cable	Neutrik	NE8MC6-M0	Equal
Cat 6a Panel Connector	D-shape CAT6 <sub>A</sub> panel connector, shielded, IDC termination, nickel housing	Neutrik	NE8DX-Y6	Equal
Cat 6a Panel Connector	D-shape CAT6 <sub>A</sub> panel connector, shielded, IDC	Neutrik	NE*FDX-Y6-B	Equal

	termination, nickel housing			
RS232 Receptacle	RS232 Panel Mount Male	Amphenol	DB9S-SFJ	Equal
RS232 Receptacle	RS232 Panel Mount Female	Amphenol	DB9S-SMJ	Equal
RS232 Connector	RS232 Inline Cable	Amphenol	DB9S-SFJ or DB9S-SMJ w/metal backshell	Equal
Crestron DM Connector	Shielded RJ45	Crestron	DM-Conn	No Equal
Crestron DM Fiber Optic	SC 50um Fiber Connector	Crestron	CRESFIBER-CONN- SC50UM-12	No Equal

### PART 3 - EXECUTION

#### 3.01 GENERAL

- A. Equipment will be installed by competent workers at locations shown on the drawings in strict accordance with approved shop drawings and manufacturer's instructions.
- B. Equipment is to be firmly held in place, with the exception of portable equipment. This shall include loudspeakers, enclosures, amplifiers, cables, etc. Fastenings and supports adequate to support their loads with a safety factor of five, unless otherwise stated.
- C. Take such precautions as necessary to prevent and guard against electro-magnetic and electro-static hum and to install the equipment so as to provide safety for the operator.
- D. Protect equipment, including patch panels, connectors, receptacles, racks, consoles, and video projectors, from construction dust and debris until final acceptance of the system.

#### 3.02 SYSTEM DEMONSTRATION AND CHECKOUT (COMMISSIONING)

- A. System installation will be certified complete and in fully adjusted working order by contractor. Fill in and submit the Avixa Audiovisual Systems Performance Verification Checklist form prior to scheduling formal commissioning.
- B. Fully Adjusted Working Order requires a system to be functional, set for normal operating conditions, and ready to be demonstrated to the AV consultant and end users for training and operation. This includes: termination of field and internal equipment rack cabling, cable labels, equipment labeling, installation of control system code, testing of devices under touch panel or button panel control, remote control panels, external control sensors, IP and network settings, image adjustments, audio mixing, level and equalization adjustments, assistive listening tests, and external sub-system device control. Fully demonstrate spares or pool equipment supplied under the contract; including auxiliary interconnecting cables and accessories.
- C. Confirm test results and data obtained and submitted for review during final commissioning, as requested.



- D. Provide as-built drawings, manuals, and configuration software available to consultant during the final testing and commissioning. System Demonstration and Testing does not define the entire scope of proof of performance of the AV systems. Detailed performance requirements are listed in Section 3.13 below.

3.03 LABELS:

- A. Except where otherwise specified, label as shown on drawings and as specified each item of rack-mounted equipment, switches, controls, and receptacles.
  - 1. Connector and Rack Panels: Constructed of engraved and filled anodized aluminum plates. Minimum 1/8" plate thickness. Dry transfer or other types of adhesive labels not acceptable.
  - 2. Rack-Mounted Equipment: Labels constructed of engraved and filled plastic laminate engraving stock. Designate function and input and output line(s) or loudspeaker(s) served by labeled equipment. Key designations to system functional and patch panel diagrams. Where possible, mount labels on blank panel directly above corresponding component. For modular equipment, provide label on inside of mainframe door identifying type of module for each slot (unless there is only one type) and gain setting as established at final checkout.
  - 3. Identification Panel: Install panel with 1/8"-high engraved characters on the front of the bank of equipment racks serving each space. Clearly identify the Project, System Installation Contractor, Architect, and System Designer in the following format:

PROJECT:	Owner's Name Address Room or spaces served Owner's technical support telephone
SYSTEM DESIGNER:	Acentech Incorporated 33 Moulton Street Cambridge, MA 02138 (617) 499-8000
SYSTEM INSTALLER:	Company Name Address Telephone
PROJECT ARCHITECT:	Company Name Address Telephone
  - 4. Receptacles: Engrave and fill receptacle label directly on mounting plate as indicated on Contract Drawings.
- B. Identify wires and cables at every termination and connection point with the specified cable markers. The contractor is strongly encouraged to use a numbering scheme that identifies cables terminating at patch panel jacks with the patch bay row and jack designation; use A, B, and C suffixes to distinguish multiple cables terminating at the same jack.
- C. Identify switches, relays, terminal blocks, etc., with reference numbers keyed to the as-built wiring diagrams.
- D. Room numbers appear on the contract documents for reference only. Labels shall reflect the Owner's final room designations.

- E. Labels and legends shall be as approved on shop drawings.
- F. Cable Markers:
  - 1. High-grade PVC clip-on or permanent-type cable markers with permanent markings, or printed vinyl tape protected by clear shrink tubing or adhesive wrap.
  - 2. Acceptable Products:
    - a. Wieland Electrovert Type C or Z.
    - b. Brady B-702 with Alpha FIT-221 series clear tubing.
    - c. Brady BMP21-PLUS.
    - d. Dymo RHINO 6000

### 3.04 MICROPHONE EQUIPMENT

- A. General:
- B. Excluding wireless microphones, each portable microphone provided with case, stand adapter, and min. 15 ft. cable with attached XLR-type connector.
- C. Condenser Gooseneck Microphone:
  - 1. Permanently mount to lectern.
  - 2. Locate to provide typical 6" to 18" working distance between microphone and lecturer's mouth.
- D. Subminiature Microphones:
  - 1. Boundary Microphone:
    - a. Mounted flush in ceilings (electrical boxes) and or furniture tops in locations as indicated.
    - b. Provide isolation from air handling noise.
    - c. Install with manufacturer provided isolation hardware.
  - 2. Multi-Element Array Microphone:
    - a. Install with manufacturer supplied hanging or wall mounting brackets.
  - 3. Hanging Microphone:
    - a. Suspended below ceilings at elevation shown or a minimum of 6" in locations as indicated.
    - b. Install with manufacturer provided isolation hardware.
- E. FM Wireless Microphone System:
  - 1. Orient antennas as recommended by manufacturer. Locate in positions shown on drawings.
  - 2. Antenna Cables: Use specified low-loss 6/U (75 ohm) or 8/U (50 ohm) cable, impedance as required.
  - 3. Except for transmitter equipment, equipment including preamps and active combiners requiring DC power provided with power supplies or powered by receivers (battery operation is not acceptable).
  - 4. Do not mount antennas or attached preamplifiers directly to any metal structure. Mount at least 3 ft. from any large metal object.
  - 5. Dual-Antenna Phase/Diversity System (Telex, Shure, Sennheiser): Use 2 antennas, both vertically oriented, observe manufacturer's minimum required spacing.
- F. Digital Wireless Microphone System:
  - 1. Install remote antennas min. ½ wavelength in distance from each other (UHF frequencies).

2. Antenna Cables: Use specified low-loss 6/U (75 ohm) or 8/U (50 ohm) cable, impedance as required by manufacturer.
3. For systems with Digital Transceivers (access point), mount with face aimed at desired coverage area.
4. Do not obstruct the microphone/transceiver line of site.
5. Observe minimum separation between mounted access point/transceivers.
6. Use RF spectrum scanning utility where required for RFI (Radio Frequency Interference) conflicts.

### 3.05 AMPLIFIERS AND DIGITAL AUDIO SIGNAL PROCESSORS

- A. Gain Control Security:
  1. Amplifiers and Signal Processing Equipment: Power amplifiers and signal processing equipment with front panel controls or power switches which are to be permanently adjusted (not normally adjusted by the operator), such as equalizers, distribution amplifiers, limiters, and audio delays, shall be furnished with lockout of front-panel controls, security panels, or be mounted on subpanel behind blank panels. Provide transparent plastic panels for viewing of indicators such as meters or LED indicators.
- B. Audio DSP and Surround Processing:
  1. Install all equipment to manufacture specifications and industry standards.
  2. Adjust the system gain and equalization to meet specifications. Adjust equalization curves as required for speech and program audio playback.
  3. Record and store all DSP configuration files.
  4. Test all functions of each piece of audio DSP equipment, including front panel and remote controlled functions.

### 3.06 LOUDSPEAKER EQUIPMENT

- A. Loudspeaker Arrays:
  1. Carefully inspect the site to verify that no obstructions, such as beams, panels, large framing members, etc. exist between high-frequency horns and any seating area covered by the horns. Immediately notify Architect of any such obstructions.
  2. Provide and install safety cable to secure all loudspeaker components and mountings.
  3. Provide all structure and framework as required to properly support the loudspeakers in the indicated locations. Provide shop drawings of proposed structure for review prior to fabrication. Obtain the stamp of a structural engineer registered in the same state as the construction site on shop drawings which depict loudspeaker cluster structure, framework and support system(s).
  4. Paint all components and provide cloth grilles for loudspeaker enclosures as required by Architect.
- B. Ceiling-Mounted Loudspeaker Enclosures and Grilles:
  1. Ceiling Enclosures: Enclosures supported directly from ceiling structure in an approved manner. Support directly by acoustical ceiling tile is NOT ACCEPTABLE.
  2. Flush and Surface-Mounted Ceiling Enclosures: Provide enclosures where indicated on drawings.
  3. Surface-Mounted Wall Enclosure: Located as indicated on drawings. Coordinate enclosure colors with the Architect.

### 3.07 ASSISTIVE LISTENING SYSTEM

- A. RF Assistive Listening System:
  - 1. Orient external coaxial dipole antenna ground plane in proper direction.
  - 2. Test all receivers with program material for noticeable dropouts in signal.
  - 3. Test all bodypack receiver accessory headphones and neckloops.
  - 4. Provide field strength data and commissioning report to AV consultant.

### 3.08 VIDEO EQUIPMENT

- A. Video Projectors:
  - 1. Verifications:
    - a. Verify lens selection, locations, and elevations shown on drawings using manufacturer's throw distance and elevation formulas for specified projector model.
  - 2. Submittals:
    - a. Provide plan and section drawings verifying image size and format, lens-to-screen distances and mounting methods.
    - b. Provide detailed drawings of custom-fabricated or stock mounts and hardware.
    - c. Provide detailed drawings of millwork or finish items required for specified screen dimensions.
    - d. Where mirrors are required, provide detailed drawings of mounting angles, reflection rays, support structures and hardware.
    - e. Where projector mounts or motorized lifts are installed by others, provide drawings to guide installer indicating installation positions allowing optimal projector performance.
  - 3. Mounting:
    - a. Install projector mount and suspend projector at location and elevation indicated on approved shop drawings.
    - b. Projector mounts and motorized lifts must meet all applicable safety and code requirements for ceiling mounted equipment.
    - c. Fixed projector mounts must be rigid and completely free of sway or rotation deviation.
    - d. Projector support pipes shall be only fixed-length pipes as required—do not use adjustable-length pipes.
    - e. For ceiling-mounted installations where screen surfaces are vertical, level projector at 0° front-to-back and side-to-side.
    - f. Position projector with lens centered on screen centerline in plan unless projector is provided with horizontal lens shift capability. Do not employ vertical or horizontal electronic keystone correction unless specifically authorized to do so.
    - g. Wherever possible, minimize hardware and cables visible from audience seating and presenter area viewpoints.
    - h. Paint exposed mounting hardware to match room interior or as instructed by Architect.
    - i. Where structural mounts or millwork openings are provided by others, verify correct positioning and dimensions before mounting projector. Provide written notification to the Owner or Architect of any discrepancies in mount positioning or stability deficiencies before projector installation.
    - j. Where rear projection screen millwork is provided by others, provide written notification to the Owner or Architect of any discrepancies in opening dimensions before screen or projector installation.
    - k. Provide all necessary projector brackets, fittings, pipes, miscellaneous hardware and wireways.
    - l. Run cabling from video projector box to projector within projector support pipe.

- m. Provide approved security cable for video projectors to accept padlock provided by owner.
  - n. Confirm that the lift and or projector is isolated from building or external vibrations.
  - o. When using an external box for projector components make sure the box is adequately ventilated and has enough AC power receptacles.
  - p. Confirm that the projector fan noise is within the manufacturer's specification.
- B. Video Display Panels:
- 1. Submittals:
    - a. Provide elevation drawings showing location of video displays for approval. Where display is part of a larger graphic display, verify exact location of display with Architect.
  - 2. Mounting:
    - a. Install display mount and display at location and elevation indicated on approved shop drawings.
    - b. For wall-mounted displays, provide mount to support display from blocking, if provided, or from wall studs. If a recessed box is provided behind display for power outlets and electronic accessories, provide mount that does not obstruct access to box.
    - c. Wherever possible, minimize hardware and cables visible from audience seating and presenter area viewpoints.
    - d. Where display is mounted in an architectural recess, verify that sufficient clearance (2" minimum) is provided for ventilation airflow.
    - e. Provide display mounts with security provisions to accept owner-provided padlocks.
- C. Pan/Tilt Video Cameras:
- 1. Submittals:
    - a. Provide elevation drawings showing location of cameras for approval.
  - 2. Mounting:
    - a. Install camera at location and elevation indicated on approved shop drawings using approved wall mount or ceiling mount bracket.
    - b. Maintain clearance for pan/tilt operational limits.
    - c. Identify and correct with the architect any light source that may interfere with the camera iris.
  - 3. Control:
    - a. Program control system to provide presets for principal views for each camera and provide means for users to modify presets.
- D. Digital Media Transmission and Switching Systems:
- 1. Extended Display Identification Data (EDID):
    - a. Do not operate digital media transmission/switching equipment in "automatic EDID" mode, unless equipment provided has no other option.
    - b. Do not include resolutions in the EDID table that cannot be handled by display(s).
    - c. For systems where laptop computers will be used in "mirroring" mode, ensure that as many possible common resolutions are included in the EDID table without violating provision of preceding paragraph.
    - d. For inputs where the source is a fixed device (i.e. a fixed part of the system) create the EDID table with a single entry, again without violating provision of preceding paragraph but one.
  - 2. HDCP Implementation:

- a. For systems containing a non-HDCP-compliant display device, such as a class capture appliance or videoconference CODEC, and where switching equipment supports the capability, dynamically configure input devices for portable equipment such as laptops to report to the equipment as non-HDCP devices when the non-compliant device is in use.

### 3.09 CONTROL EQUIPMENT

- A. Audiovisual Control System:
  1. Do not mount wireless receiver gateways or antennas near large metal objects.
  2. Carefully coordinate with manufacturer and with Architect the dimensions and mounting conditions of all items.
  3. Provide all required cable, relays, and miscellaneous hardware to interface the audiovisual control system with controlled equipment.
  4. Install all components so as to use the maximum amount of any tally signals provided by the controlled equipment, including lighting dimmer systems and video playback and recording devices.
  5. Mount infrared LED emitter probes to face of controlled equipment using thin layer of clear silicone caulk. Position probe to provide control of device while continuing to allow use of infrared control supplied with equipment. Secure probe cables to prevent probe from being accidentally pulled from equipment during normal system operation.
- B. Ethernet/IP/Local Area Network Accessibility and Control:
  1. Coordinate Ethernet connectivity and IP addressing of control devices with Electrical Contractor and the Communications/Technology management of the facility. Owner will provide all required IP addresses to AV contractor.
  2. Provide owner with remote control and management software interfacing via Local Area Network access from PC to any IP addressed control devices.
  3. Coordinate with end-user and Communication/Technology management of the facility, on POP-3 email notification of system service issues where desired and /or where possible. Coordinate with Owner and Communications/Technology management of the facility on POP-3 email of service or security issues in case of failure or disconnection of any bi-directional (e.g. RS-232 or Cresnet/AXLINK) device.
  4. Verify requirements of system control via IP with Owner and Consultant.
- C. Local Area Network Management Programming:
  1. General:
    - a. Verify requirements of room management/scheduling via IP with Owner and Consultant.
  2. Room AV system control:
    - a. Use included software and Ethernet connectivity hardware of control systems.
    - b. Program remote site portal to replicate appearance and function of control touch panel.
    - c. Control program can be launched locally from designated AV technician computers as stand-alone ".exe" Windows-based executable file.
  3. Remote System Status Monitoring and Management Programming:
    - a. Use included software and Ethernet connectivity hardware of control systems.
    - b. Provide system-wide and room-specific monitoring and management including:
      - 1) Room activity and system shut-down scheduling.
      - 2) Multiple user level password settings, including password change and lock-out of certain user passwords at certain times.

- 
- D. Audiovisual Control System Programming:
1. All programming to be performed by programmer certified by the manufacturer of the AV control system equipment provided.
  2. Program system or instruct AV Control System Manufacturer to program system as instructed by the AV Consultant and the Owner, and as indicated on the drawings so that all devices are controlled in a logical manner, and to take full benefit of the capabilities of the Control System.
  3. Submit for approval changes to programming or control panels required by actual conditions (e.g. number of dimming system presets).
  4. Refine and adjust, as required, programming to operate in a logical and consistent fashion. Make revisions to program as directed by the AV Consultant at checkout to correct operational inconsistencies or to properly control devices.
  5. Ascertain that the system is optimally programmed for smooth transitions between media uses and for minimal wear-and-tear on equipment and audiovisual media.
  6. Verify that video playback device transports, etc., are stopped when another input source is selected, unless playback device is routed to a different destination from the selected source.
  7. Wherever possible, utilize status feedback of source equipment, dimming systems, etc., to indicate to the control system and user the actual operating mode of the equipment. When feedback is not available (e.g. consumer playback equipment) program control system to issue commands as required to minimize status reporting errors.
  8. Provide color electronic drawing files of screen layouts of touchscreen control panels for approval prior to system programming.
  9. Distinguish between primary and secondary control buttons by intensity or color. If available, use "3D" buttons to indicate button activation as visually "depressed". Avoid excessive use of primary or other bold colors.
- E. Color Video Touch-Screen Control Panels:
1. Submit panel graphics (including text, buttons, colors, images, backgrounds etc.), as well as panel flips, sub-panels and overall screen logic flow to the Owner and Consultant for review and approval.
  2. Use Crestron Studio® or AMX TP Design 5 (G5 panel support) for panel logic programming and design; make software files available directly to the end user upon request, free of charge.
  3. Join numbers (other than those reserved for panel logic), hardware programming and all other installation requirements including programming software and computers are the responsibility of the installing contractor.
  4. Any adjustments, revisions, modifications, etc. to the panel graphics and control system required for complete operation are the responsibility of the installing contractor.
- F. Lectern Control Panel:
1. Coordinate the touch panel cut-out with furniture manufacturer.
  2. Provide furniture manufacturer with mounting template.
  3. Verify size and mounting conditions with Architect.
- G. Master and Portable Control Panels:
1. Install local control panels in associated backboxes, as required.
  2. Verify size and mounting conditions with Architect.
  3. Confirm operation of portable wireless panels, WAP access points, and Gateways.
- H. Control System Functions:

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1. Following are general descriptions and guidelines for control system panel functions and layouts:
  - a. Turn system power on/off.
  - b. Input Source selection.
  - c. Separate speech and program audio volume controls. Preset microphone and audio playback levels on startup.
  - d. Recovery from power outage.
  - e. Control digital signal processors to provide system presets indicated in this specification or on the AV drawings or others as required.
  - f. AC power failure and switchover to UPS.
  - g. Others as identified elsewhere in the Contract Documents or required.
  - h. After system shut-down, system will restart with default settings restored.
2. Following are specific descriptions and guidelines for control system panel functions and layouts:
  - a. Volume Control (provide separate microphone and program audio volume controls where applicable).
  - b. Projection screen up/down.
  - c. Transport controls for all applicable AV sources.
  - d. Select which video input is actively displaying and playing audio through the AV system.
  - e. Others as identified elsewhere in the Contract Documents or required.
3. Where applicable, configure the audiovisual control system(s) with the following operation(s):
  - a. Control system shall communicate with video display devices (particularly video projectors) during start-up and shut-down. Feedback shall be provided on the control panel indicating when the projector is cooling down, and inform the user that the projector cannot be restarted until cool-down is complete.
4. Interface with Fire Alarm System: The audiovisual system shall connect to the FAS as identified on the drawings. Systems shall be muted when triggered by the FAS.

### 3.10 NETWORKED AV & SECURITY

- A. All equipment to be configured to prevent unauthorized users from access to the systems and network and prevent disclosure of confidential information.
- B. Default passwords of internet connected audiovisual equipment are readily known and can be used as a means to access network equipment by unauthorized users. AV networked devices may include any device with a wireless or wired Ethernet port.
  1. Assign role based access control with different levels of access and permissions for each user type:
    - a. Admin – Ability to make changes to network, security configurations, and user accounts.
    - b. AV Configuration – Ability to make changes to AV Parameters.
    - c. System User – System operation only.
    - d. Others as required by the Owner.
  2. Change all passwords from default values to project specific passwords. Follow industry recommended password strength standards when choosing new passwords.
  3. Provide new passwords to the Owner.
  4. Provide instructions to change passwords.
- C. AV Network Switches:
  1. Do not connect unauthorized AV network switches to the Owner's LAN.



2. Provide logical separation of AV and IT networks through hardware and VLAN's.
3. Disable unoccupied ports and services on managed switches.

### 3.11 PROJECTION SCREENS

- A. General: Install projection screens at locations indicated to comply with screen manufacturer's written instructions.
- B. Install front-projection screens with screen cases in position and relationship to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
  1. Test electrically operated units to verify that screen, controls, limit switches, closure, and other operating components are in optimum functioning condition.

### 3.12 RACKS, CABLES, CONNECTORS, AND MISCELLANEOUS EQUIPMENT

- A. Wiring and Interconnections:
  1. General:
    - a. Exercise care in wiring to avoid damage to cables and equipment.
    - b. Make all joints and connections with rosin-core solder or approved mechanical connectors, except mechanical connectors are NOT acceptable on microphone lines. Connections to transformer leads for distributed loudspeakers may be made using properly-sized wire nuts or nylon-insulated pigtail crimp connectors such as Waldom CE series. Wire nuts are not acceptable except at individual loudspeakers.
    - c. All connections to screw-type terminals shall be made using spade lugs. Bare or tinned wire is not acceptable.
    - d. All connections to lugless compression-type screw terminals shall be made using bare wire only. Do not tin wire.
    - e. All wiring executed in strict adherence to standard broadcast practices. This includes:
      - 1) Dress cables in conveniently sized bundles, combed into parallel runs, either laced or banded with sufficient plastic ties.
      - 2) For equipment mounted on glides, or otherwise requiring servicing from the front of the rack incorporate a cable "service loop" of sufficient length to permit the equipment to be pulled forward from the rack for servicing.
      - 3) Support cables and bundles with sufficient plastic ties and support bars to ensure that no strain is placed on any connections or connectors.
      - 4) Organize cables and cable bundles behind patch bays to permit easy access to the patch panels to add or remove cables.
      - 5) Place cable markers 3"-5" back from video connectors to permit easy viewing. Do not bind markers into cable bundles.
    - f. All audio signal lines carried by twisted-pair cable and switched with two poles per line unless noted otherwise. Do not tie one side of audio line to other audio lines.
  2. Grounding:
    - a. Ground equipment, racks, and audio line shields to independent audio system ground ONLY as shown on drawings. If not shown on drawings, ground case of power striplines in equipment racks to the racks and directly to isolated ground buss in the power panel or to power system ground at the building AC service entry only.
    - b. Ground all conduits ONLY to power system ground. Insulate all conduits and electrical boxes from sound system, including equipment racks and audio system ground.

- c. Insulate all conductors in conduit, including shields, from the conduit, back boxes, and from each other for the entire conduit length.
  - d. Equipment Racks:
  - e. Install equipment in racks to permit access to all equipment for service. Transformers, relays, terminal blocks, etc., mounted in rear of racks behind other equipment shall not prevent access to equipment connections or shall be mounted on hinged panels to permit access.
  - f. Wire all racks completely in the shop. No internal rack wiring to be done on the job site.
  - g. Install equipment in racks with ventilating panels as required to provide adequate ventilation and according to equipment manufacturer's recommendations.
  - h. Connect all microphone, DC control, and line level cables to equipment racks via specified audio terminal blocks. External lines to patch bay terminated directly on patch bay terminal blocks.
  - i. Connect loudspeaker lines with equipment racks via specified terminal blocks. Use spade lugs if barrier strips are used. Do not buss commons together. Do not ground.
  - j. No signal or control lines shall leave a rack without connecting via terminal blocks.
  - k. Provide unused panel space with blank or ventilating panels.
  - l. Locate patch panels at least 30" above floor.
  - m. Locate free-standing racks as indicated and to provide access to rear without moving racks.
  - n. For permanently located racks containing equipment on glides, with desk/control surfaces, or which may be unsteady from cantilevered devices or personnel, bolt all racks to the concrete floor slab (through the access flooring if necessary).
  - o. Bolt adjacent racks together on at least 3 locations along both the front and rear edges.
  - p. Equip racks not bolted to the floor because of service access with "Anti-tip" bases, casters and brake.
3. Wall-Mount Equipment Racks:
- a. Drywall Partitions: Before installation of drywall material, install blocking or other bracing required to support weight of equipment rack.
  - b. If internal wall bracing is not provided before wall is closed in, install 3/4" plywood mounting plate secured with drywall screws to at least three separate studs. Size of plate and number of mounting screws as required to support weight of rack. Paint plywood to match wall finish. Strut channel hardware support frame attached to structure is also acceptable.
4. Conduit:
- a. Run lines in metallic conduit or wireways unless otherwise indicated. Run microphone level, line level, loudspeaker level, and DC control wiring each in separate conduit.
  - b. Do not locate AC power lines in conduit containing network, audio or video lines.
  - c. Do not splice lines in conduit.
5. Exposed Cables:
- a. Line level or mic level lines exposed above countertops (such as those lines serving mixing consoles, program source equipment, etc.) shall be rubber-jacketed, AWG #20 two conductor with braided shield such as Belden 8412 or equivalent. Plastic or vinyl jacketed cables are not acceptable.
6. Receptacles:
- a. Wall-mounted receptacles in metal boxes at building standard receptacle height unless otherwise indicated.
  - b. Floor-mounted receptacles in flush floor boxes with flush lids.

- c. Catwalk-mounted receptacles in metal boxes mounted on catwalk hangers at building standard receptacle height.
- 7. Balanced Receptacles:
  - a. Attach "XLR" type connectors to mounting plates with machine screws unless using single-hole mounting types with threaded sleeve and mounting index to prevent rotation.
- 8. Unbalanced Receptacles:
  - a. Install 1/4" phone jacks to mounting plates with insulating washer and sleeve to electrically isolate the jack from the electrical box and conduit.
  - b. Install isolation/balancing transformers in electrical boxes or wireways adjacent to each unbalanced receptacle as indicated.
  - c. Wire input receptacles to short the line except with connector inserted.
- 9. Video Receptacles: Install feed-through BNC receptacles to mounting plates with insulating washer and sleeve to electrically isolate the receptacle from the electrical box and conduit.
- 10. Loudspeaker Wiring:
  - a. Note that Functional Diagrams or Conduit Drawings indicate required home runs for loudspeakers and loudspeaker zones. Home run requirements depend on line power loss as well as functional considerations and shall be strictly adhered to.
  - b. Loudspeaker lines above ceilings installed using specified UL listed plenum-rated cable. Lines installed as high as possible, directly to undersides of floor or to roof decks above, using strain reliefs, cable ties, or other approved method to attach lines securely and neatly to building structure. Lines installed loosely or otherwise on top of ceiling tiles, ductwork, etc., are NOT ACCEPTABLE.
  - c. Floor-to-floor lines installed using specified UL listed plenum-rated cable. Attach lines securely and neatly to building structure using Owner-approved method.
- 11. Fiber Optic Cables:
  - a. Terminate fiber optic strands with connectors compatible with connectors on equipment and with fiber optic cables provided.
  - b. Use of compatible quick-connection system is recommended (e.g. Corning UniCam® Pretium Installation Tool Kit for Corning fiber cable; Belden FiberExpress System or West Penn Wire Fiber products with Optimax Installation Tool Kit).
  - c. Neatly coil surplus fiber cable using bend radius larger than manufacturer's minimum bend radius and secure to rack to prevent crimping or damage to cable, or provide rack-mount fiber management.

### 3.13 SYSTEM PERFORMANCE TESTS AND ADJUSTMENTS

- A. Test equipment to verify conformance with manufacturer's performance specifications and with this specification.
  - 1. Verify systems meet the requirements identified in this section or otherwise within the contract.
  - 2. Adjust systems as required to conform to testing requirements for any failed tests.
  - 3. Provide results of final, re-calibrated system testing to Architect and AV Consultant for review and approval prior to scheduling of commissioning testing by AV Consultant or any user training provided to Owner.
- B. Audio Systems:
  - 1. Absolute Impedance:
    - a. Set any loudspeaker level controls at zero attenuation. Measure absolute impedance value of each loudspeaker line at 250, 1000, and 4000 Hz, without amplifier connected but with loudspeakers connected. Impedance shall be at least 90% of rated load

- impedance of respective amplifier. Check resistance of lines to loudspeaker and microphone receptacles, with receptacles open and short circuited.
2. Hum and Noise Level:
    - a. Adjust gain controls for optimum signal-to-noise ratio and full amplifier output with -55 dBm level at a microphone input and 0 dBm at line-level input.
    - b. Without changing gain, terminate microphone and line-level inputs with shielded resistors of 150 and 600 ohms, respectively.
    - c. Measure overall hum and noise level at each power amplifier output for each input channel. Level shall be at least 80 dB below rated power output of amplifier over a bandwidth of 20-20,000 Hz.
  3. Electrical Distortion:
    - a. Load power amplifiers with resistors matching nominal impedance of output terminals used in system in place of actual loudspeaker loads.
    - b. Adjust gain controls as for hum and noise level tests.
    - c. Apply 1000 Hz sine-wave signal from an oscillator having less than 0.1% total harmonic distortion to each microphone and line-level input at level required to produce measured full amplifier output.
    - d. Distortion shall measure less than 0.1%.
  4. Parasitic Oscillation and RF Pickup:
    - a. Set up system for each specified mode of operation.
    - b. Use 50 - 100 MHz bandwidth oscilloscope and loudspeaker monitoring.
    - c. Check to ensure that system is free of spurious oscillation and RF pickup in the absence of any input signal and also with system driven momentarily to full output at 160 Hz.
  5. Buzzes, Rattles, Distortion:
    - a. Apply a high-quality music signal to the system. Adjust the loudness for frequent peaks at its specified maximum sound pressure level.
    - b. Apply sine-wave sweep from 50-50,000 Hz at 6 dB below full amplifier power.
    - c. In both cases, listen carefully for buzzes, rattles, and objectionable distortion.
    - d. Correct causes of such defects. If cause is outside the system, promptly notify the Architect and his Consultant, indicating cause and suggested corrective procedures.
  6. Level Balance: Adjust level controls for items of similar equipment for identical measured voltage gain.
  7. Measure system acoustical performance using a sound level meter set for "slow" meter damping except as otherwise noted, and flat response with random incidence at a height of 4 to 5 feet. Interior finishes and furnishings shall be in place, and system gain shall be adjusted to provide levels of 70 to 80 dB and at least 10 dB above background noise at the measuring locations for these tests, except as otherwise noted. Include the following tests and adjustments:
    - a. Frequency Response:
      - 1) Measure loudspeaker frequency response with control equalization set for flat response, using 1/3-octave bands of filtered pink noise centered on ANSI preferred frequencies, or broadband calibrated pink noise measured in 1/3-octave bands using a calibrated real-time analyzer.
      - 2) Adjust equalization to provide average system response within  $\pm 3$  dB of a response (0 dB) which is flat from 63-2500 Hz and slopes uniformly from 0 dB at 2500 Hz to -5 dB at 10,000 Hz.
    - b. Uniformity of Coverage:
      - 1) Use 4000 Hz octave band of random noise as test signal output to loudspeakers.
      - 2) Lateral Uniformity:  $\pm 2$  dB at positions equidistant from front of hall.

- 
- 3) Front-to-Back Uniformity: Decreasing linearly within  $\pm 2$  dB from 0 dB at front of hall to -6 dB at rear as measured on the hall center line.
  - c. Maximum Output Level:
    - 1) Measure with standard "fast" meter damping.
    - 2) Loudspeaker Cluster: Capable of providing 95 dB SPL in the audience area on axis of any high-frequency horn and employing wideband recorded music as a test signal.
    - 3) Distributed Loudspeaker Systems: Capable of providing 95 dB SPL on axis of any loudspeaker and using wideband recorded music as a test signal.
  - d. Speaker Polarity:
    - 1) Using a NTI Minirator MR-PRO, use the generator Sawtooth (WAV) pattern to check the polarity of each program loudspeaker. When the speaker polarity is normal the measuring meter will display POSITIVE.
    - 2) Correct the polarity of any speaker out of phase.
    - 3) Record results.
- C. Video Systems: Test the video system following the approved Proof-of-Performance Test Plan to verify that it meets these minimum performance requirements. .
1. Video Standards:
    - a. Frequency Response:  $\pm 0.5$  dB, 60 to 4.18 MHz.
    - b. Crosstalk: -40 dB at 3.58 MHz.
    - c. S/N Ratio: 45 dB, DC to 4.18 MHz, unweighted, peak to RMS.
    - d. Hum: <10 mV peak to peak.
    - e. Line and Field Tilt: 2% with 60 Hz square wave.
    - f. Differential Gain: 1% at 3.58 MHz, 10-90% APL.
    - g. Differential Phase:  $\pm 1^\circ$  at 3.58 MHz, 10-90% APL.
    - h. Envelope Delay:  $\pm 0.1$  microseconds, 0.2 to 2.1 MHz;  $\pm 0.05$  microseconds at 3.58 MHz.
    - i. Color Production: Primary and Complementary Colors (R, G, B, Cy, Yl, Mg) at 75% saturation within inner 50% of the inner boxes ( $\pm 2.5^\circ$ ) when viewed on vectorscope.
    - j. Signal Levels: 1 V p-p,  $\pm 1$  IRE, at 100% peak white color bar.
  2. Audio Standards:
    - a. Frequency Response:  $\pm 1$  dB, 30-15,000 Hz.
    - b. Hum and Noise: -80 dBu, 30-15,000 Hz, unweighted.
    - c. Distortion: 0.25% THD, 30-15,000 Hz.
    - d. Signal Levels: +4dBu.
- D. Video Display Systems: Calibrate each video display system as follows:
1. For projected displays align the image with the black borders of the screen:
    - a. If the display uses a variety of aspect ratios use the zoom lens to align the image with the black borders of the screen. If the image does not fill the screen (e.g., a 16:9 screen with 4:3 image) then align top and bottom of image with black border of screen.
  2. Allow projector or flat panel display to warm up for a minimum of 30 minutes.
  3. Turn off video enhancement circuitry options including image overscan.
  4. Set factory color temperature to warm, D65, or other setting to achieve closest approximation to 6500°K color temperature. Set sharpness control to minimum.
  5. Adjust black level and video gain:
    - a. Reduce ambient light to less than 2 foot-candles of ambient light on screen.
    - b. Using the PLUGE (Picture Lineup Generating Equipment) pattern from the signal generator, adjust the brightness (brightness control on most displays) until the

- “blacker-than-black” bar is visible on the screen and then decrease brightness until the bar just disappears.
    - c. Using the grayscale pattern from the signal generator, adjust the contrast control so that the highest grayscale transition disappears and then decrease contrast to make the transition just visible.
    - d. Repeat steps b and c as required for stable results. Record control settings.
  - 6. Adjust color level or gain:
    - a. Display SMPTE color bar test pattern. Shut off red and green channels on display or use a blue filter to observe the display.
    - b. Adjust color and tint controls for optimum blue balance.
    - c. With only red channel operating or with red filter check red balance. Repeat for green channel. If red and/or green balance is significantly out of balance, make minor changes to color and tint controls to achieve best compromise for color control settings.
    - d. Record control settings.
  - 7. Adjust sharpness:
    - a. Using the S802B or similar pattern, adjust sharpness control for maximum sharpness without ringing (duplicate lines).
    - b. Record control setting.
  - 8. Brightness, Uniformity, and Contrast Ratio:
    - a. Using the ANSI 9-zone pattern and a spot photometer, measure screen brightness in each zone. Calculate screen brightness as the average of the nine zones and uniformity as the maximum variation from the average.
    - b. For a projected image, use the ANSI 16-zone checkerboard test pattern and viewing locations measure the contrast ratio of representative white squares vs. adjacent black squares. Repeat contrast measurement with room lighting at representative viewing level (typically 7fc in seating area).
    - c. Record measurements.
- E. Digital Video Systems: Provide the following information for systems employing HDMI and/or digital media signals:
  - 1. The video timing (e.g. 1080p 30 fps Deep Color or 1366x768 30 Hz), HDCP use, and audio format of each non-portable digital source when operating.
  - 2. The video timings and supported audio formats for each connected sink.
  - 3. The video timings and supported audio formats presented in the EDID of sinks to each source – indicate the preferred video timing.
  - 4. The length of cable used on HDMI or shielded twisted pair cables used for AV distribution.
  - 5. The data rate supported by each shielded twisted pair cable used for AV distribution.
- F. Video Projectors:
  - 1. Provide written verification of completion of the above procedures.
  - 2. After completion of projector set-up, record the following items for inclusion in pre-acceptance test reports:
    - a. Current lamp life hours shown on projector (include date), if lamps are used as a light source.
    - b. Provide security service code if required by owner.
    - c. Set-up software version number.
    - d. Projector, input modules, and decoder card serial numbers for each system.
    - e. Date of manufacture.
    - f. Date of installation.

- g. List of supplied accessories (remotes, lens caps, tools, cables, backup discs, owner's manuals).
- G. Remote Control Systems: Test each function of each control station or touch panel to verify proper operation and that each illuminated button and indicator operates properly when the associated function is selected.
- H. Test Reports and Certificates: Submit results of tests and adjustments conducted above and certification that the installation is complete and ready for checkout as specified under SUBMITTALS in PART I - GENERAL.

#### 3.14 FINAL ADJUSTMENTS AND ACCEPTANCE TESTS

- A. Upon approval of the contractor's test report, and at a time set by the Architect, assist the Consultant(s) in performing final system adjustments and acceptance tests. Provide labor, material, tools, and measurement equipment necessary for these tests and adjustments, including the test equipment and material specified in Article 1.1, except as otherwise specified.
- B. Supply sufficient representatives who are thoroughly familiar with details of the system to assist in the performance of these tests, and include the field supervisor in charge during the course of the installation work.
- C. Budget 8 working hours for the performance of these tests and adjustments. If final acceptance is delayed beyond this period because of installation not in accordance with these specifications, pay for additional time and expenses of Consultant(s) during any resultant extension of the acceptance testing period.
- D. Acceptance tests may include speech intelligibility surveys and subjective evaluations by observers listening at various positions under various operating conditions, using speech, music, and live or recorded effects material.
- E. Measurement of frequency response, distortion, noise, or other characteristics may be performed on any item or group of items deemed necessary to determine conformity with specifications.
- F. Adjustments: Adjust the system as instructed by the Consultant. Adjustments may be required to any portion of the system including:
  - 1. High-frequency horn aiming.
  - 2. Equalization and level balance.
  - 3. Timing and functioning of the audiovisual control system.
  - 4. Video projector alignment, contrast, brightness, and color content.

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Section 28 00 00  
SECURITY SYSTEM  
(Filed Sub-Sub Bid Required)

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Section 28 00 00  
SECURITY SYSTEM  
(Filed Sub-Sub Bid Required)

**PART 1 - GENERAL**

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.
- B. FILED SUB-SUB-BID REQUIRING A PARAGRAPH "E" LISTING on the FORM FOR SUB-BID required per M.G.L. Chapter 149 Section 44A to 44L, as amended to date. The Electrical Subcontractor will be responsible for all related building preparation and coordination, see specification for additional Paragraph "E" Listing requirements of the Listed Systems Contractor, and coordination of responsibilities.
- C. Section 28 00 00 INTEGRATED ELECTRONIC SECURITY SYSTEM shall be a Filed Sub-Sub Bid of Section 26 00 10 ELECTRICAL, requiring a Paragraph "E" Listing on the FORM FOR SUB-BID
- D. This Section shall be provided by a qualified Systems Contractor.
  - 1. The Systems Contractor shall be DCAM Certified by the state of Massachusetts Division of Capital Asset Management, in the category of: ALARM SYSTEMS.

1.2 RELATED DOCUMENTS

- A. All of the Contract Documents, including Drawings, General and Supplementary Conditions and Division 01 - General Requirements, apply to the Work of this Section.
- B. Carefully examine all of the Contract Documents for requirements which affect the Work of this Section. The exact scope of Work of this Section cannot be determined without a thorough review of all specification Sections and other Contract Documents.
- C. Refer to Section 012300, Alternates, for alternates which may affect the work of this Section.

1.3 COOPERATION AND COORDINATION WITH OTHER TRADES

- A. The work shall be so performed that the progress of the entire building construction, including all other trades, shall not be delayed and not interfered with. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as directed.
- B. Electrical contractor shall provide box, conduit, pathways, 120V provisions and coordination only for this section. The integrated electronic security system components, wiring, and programming as described in this section will be provided by the General Contractor (GC). Electrical contractor to review this specification for coordination.

- C. Section Includes:
  - 1. One or more security access networked controllers.
  - 2. Security access controllers connected to high-speed electronic-data transmission network.
  - 3. Video Surveillance and all CCTV components, storage servers and integration software.
  - 4. Intrusion Detection system and integration components to access control and CCTV.
  - 5. Network switches required for "IESS" system.
  - 6. Integrated door communication and video intercom system.
- D. Related Sections:
  - 1. Division 08 "All" for coordination with door hardware systems.
  - 2. Division 23 "HVAC Instrumentation and Controls"
  - 3. Division 26 "All"

#### 1.4 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. CPU: Central processing unit.
- C. Credential: Data assigned to an entity and used to identify that entity.
- D. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- E. I/O: Input/Output.
- F. LAN: Local area network.
- G. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
- H. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.
- I. RAS: Remote access services.
- J. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- K. UPS: Uninterruptible power supply.
- L. USB: Universal serial bus.
- M. WAN: Wide area network.

- N. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- O. Workstation: A PC with software that is configured for specific, limited security-system functions.
- P. IESS: Integrated Electronic Security System

#### 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Diagrams for cable management system.
  - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
  - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
    - a. Controller layouts and interconnecting wiring.
    - b. Each security device and wiring back to controllers.
    - c. Full wiring diagram with all connections.
  - 4. Cable Administration Drawings: As specified in "Identification" Article.
  - 5. Battery and charger calculations for central station, workstations, and controllers.
  - 6. Video storage calculations.
- C. Samples: For card readers, rex devices, and keypads, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.
- D. Other Action Submittals:
  - 1. Project planning documents as specified in Part 3.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: Provide operation and maintenance for IESS per Division 01, Section 01 77 00.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
  - 1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International. Provide current certification with shop drawings.
  - 2. The installation contractor must possess a MA department of public safety 'S' license.
    - a. Installing Contractor shall contain an S-License in conformance with M.G.L. Chapter 147 Sections 57 through 61.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70, "National Electrical Code."
- D. Comply with SIA DC-01, SIA DC-03 and SIA DC-07.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Central Station, Workstations, and Controllers:
  - 1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F and not more than 80 percent relative humidity, noncondensing.
  - 2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
  - 3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
  - 4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

## 1.8 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  - 1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
  - 2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in [air-conditioned] [temperature-controlled] indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

3. Outdoor Environment: NEMA 250, NEMA 250, Type 4X enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick.

## **PART 2 - PRODUCTS**

### **2.1 MISCELLANEOUS CABLING SYSTEMS (for Security, CCTV, and Card Access)**

- A. This contractor shall provide and terminate all security field devices for intrusion, access control, and CCTV IP Camera Systems, cabling per manufacturer's recommendations for a completely operational system as specified.
- B. CCTV System Cabling, provide cabling as required for a completely operational CCTV System.
  1. Camera cabling:
    - a. Provide and terminate cabling between camera locations and Head End location.
    - b. Each IP camera shall be connected to its respective network switch using CAT 6A cable as specified elsewhere in this specification.
    - c. Provide additional cabling as required per manufacturer's recommendations.
  2. Keyboard/Mouse cabling:
    - a. Provide cabling as required per manufacturer's recommendations.
- C. Access Control System.
  1. Proximity Card Reader; the cable requirements of the card reader shall be a minimum 22 AWG/6 shielded. Door Contact: The cable requirements for a door contact is 18 AWG/2. Wire to line monitoring module at each door. Run another 18 AWG/2 direct form the dual output door contact to the access control system controller.
  2. Request-to-exit device; for every request-to-exit symbol shown, provide 2/18 AWG to security control power supply and 2/22 AWG to line monitoring module at each door. Home run all cable to the access control panel.
  3. Electric lock; Provide 4/18 AWG per every door locking device. Home run all cabling for the electric strikes to the electric strike power supply. Home run all cabling for the magnetic locks to the magnetic lock power supply. The electrical contractor shall furnish 120 VAC where necessary. Run a 14 AWG/2 from the access control panel controller to the local door power supply (door power supply and hardware to be furnished by door hardware provider).
- D. Cable Color configuration:
  1. - Orange - Wireless
  2. - Green - Security/Card Access
  3. - White - VoIP
  4. - Blue - Data

5. - Yellow - BMS Connections

2.2 EQUIPMENT CABINETS

- A. Provide equipment cabinets to house all security equipment, communication equipment, telephone/data equipment, and audio visual equipment. Racks shall be located as shown on the drawings.
- B. Manufacturer: Provide products meeting the requirements of the Drawings and Specifications from one of the following Manufacturers or equal:
  - 1. Chatsworth, Great Lakes.
  - 2. Winsted
  - 3. Lowell
  - 4. Or equal.
- C. Equipment Cabinets
  - 1. Equipment Cabinets shall be seven feet (2134 mm) high, 24 inches (600 mm) wide, 31.5 inches (800 mm) deep, free standing cabinets as indicated on the drawings. These cabinets are also known as Primary Distribution cabinets, Remote Distribution cabinets, CCTV cabinets, AV cabinets, etc. Cabinet features shall include the following:
    - a. Cabinets shall be welded construction, steel or aluminum, piano hinged doors with keyed locks and access handles on front and rear. Door locks shall be keyed alike. Color shall be approved by the Architect. Front door shall have integral shatter proof vision panels in a metal frame.
    - b. Integral EIA nineteen inch (518 mm) wide, open bay equipment rack. Rack shall be as described herein this specification. Rack shall be located within the cabinet in order to properly mount all passive and active electronic components.
    - c. Shelves for electronic equipment with load carrying capacity to support at least 125 percent of each piece of electronic equipment weight. Shelves shall have adequate openings within them to dissipate heat and allow for adequate electronic equipment ventilation.
    - d. Mounting brackets specifically designed to support the equipment installed within the cabinet.
    - e. Hook and loop (Velcro) cable strain relief system on rear of rack to support horizontal and backbone cables. Tie-wraps are specifically prohibited.
    - f. Hook and loop (Velcro) horizontal and vertical cable management on front of rack to support patch cable and cross connect wiring. Tie-wraps are specifically prohibited.
    - g. Hook and loop (Velcro) cable management system independent of telecommunications cabling management to properly dress the electronic equipment power cords through the cabinet maintaining as much clearances between the two as possible. Tie-wraps are specifically prohibited.



- h. Cabinets are to be design for convection ventilation, no fans shall be used. The individual cabinet shall have adequate ventilation in order to have a temperature within the cabinet be no greater than 88 degrees F based on an ambient room temperature of 78 degrees F in the warmer months of the year and 68 degrees F in the colder months of the year.
- i. Bonding and grounding cables for all equipment not directly bolted to equipment rack (i.e shelf mounted electronic equipment, etc.).
- j. Bonding and grounding buss bar with individual set screw terminals for at least six #6 Cu. bonding cables.
- k. Surge protected power strip as described in this specification.
- l. Patch panels as described in this specification.
- m. Blank/louvered panels where required to fill gaps between equipment within the rack.
- n. All hardware, supplementary steel, channel and supports as required to properly assemble the cabinet and support it to the building structure.

### 2.3 SURGE PROTECTED POWER STRIP

- A. Manufacturer: Provide products meeting the requirements of the Drawings and Specifications from one of the following Manufacturers:
  - 1. Wiremold Sentrex, TrippLite, S.L. Weber or equal.
- B. Surge protected power strip shall be rack mount type with 10 ft. cord.
- C. Surge protected power strip with six NEMA 5-15R outlets 15 amp capacity, 120 volts, UL 1449 listed, maximum surge current of 33,000 amps, clamping voltage of 260 volts, maximum 5 picosecond response time, resettable overload circuit breaker, surge suppression warning light, surge protection for line to neutral, line to ground, neutral to ground, EMI/RFI filters. One required for each load up to 1200 watts (total of individual equipment loads).

### 2.4 CABLE SUPPORTS

- A. Manufacturer: Provide products meeting the requirements of the Drawings and Specifications from one of the following manufacturer's:
  - J-Hooks: Caddy, Chatsworth, Mono-System, or equal.
  - Hook and Loop Fasteners: Chatsworth, Ortronics, Siemons, or equal.
  - Cable Ties: DEK, Panduit, Amp, 3M, T&B, or equal.
  - Beam Clamps: Burndy, Minerallac, Kindorff, Steel City, OZ/Gedney, or euqal.
  - Split Mesh Strain Reliefs (Kellums): Hubbell, Woodhead, or equal.
- B. J-Hooks shall be sized to correctly support the number of cables, which pass through them. Under no circumstances shall cable quantity exceed 50 in any given support. Fill capacity shall be as required by code for conduit. That is to say that every J-Hook shall have a maximum of 40 percent fill capacity. Install additional supports as required.

- C. Hook and loop fasteners shall be designed for their specific application. For example, if a hook and loop fastener is used to support cables to a rack, it shall have a grommeted outlet for use with a 10-32 rack mounting screw.
- D. Cable-ties shall be correctly sized to support the quantity and types of cables installed.
- E. Beam clamps shall be steel with threaded bolt type closure. Spring steel or "quick-clip" type clamps are prohibited.
- F. Split mesh strain reliefs shall be properly sized for each cable that they support. Only one cable shall be installed in each split mesh strain relief.

## 2.5 BONDING AND GROUNDING JUMPER CABLE

- A. Manufacturer: Provide products meeting the requirements of the Drawings and Specifications from one of the following manufacturers:
  - 1. Belden (No. 8669) or equal.
- B. Jumper cable shall be hollow braided, 60 amp capacity, copper.
- C. Provide equal conduct of as described in "B" above for aluminum equipment.
- D. Jumpers shall have compression or exothermic type terminals on both ends of cables. Terminals shall be compatible with jumper cable material and equipment material in order to not have any degenerative reaction.

## 2.6 UNSHIELDED TWISTED PAIR (UTP) CABLING SYSTEMS

- A. Provide all security data cabling as specified herein and shown on the Security drawings. The security cable and jacks shall be red in color.
- B. Manufacturer: Provide products meeting the requirements of the Drawings and Specifications from one of the following manufacturer's or equal:
  - Wire and Cable: Belden, Berk-Tek, CommScope, General Cable, Mohawk, or equal.
  - Patch Panels: Hubbell, Ortronics, Panduit, or equal
  - Patch Cables: Shall be provided by patch panel, Outlet or wire and cable manufacturer.
  - Cable Management: Shall be provided by patch panel manufacturer.

NOTE: Each of the products listed above shall be provided by a single manufacturer.
- C. UTP Pin/pair Termination Assignment
  - 1. The UTP cabling systems shall have EIA/TIA 568B Series standard pin/pair termination assignment. All conductors provided shall be properly and consistently terminated at both ends throughout the entire systems.
- D. Horizontal Cable –Security Data
  - 1. Provide & terminate cabling from each camera location to applicable IDF/MDF/Low Voltage rack locations.
  - 2. Data Cable shall be TIA/EIA-568-B.2-1 Category 6A Unshielded Twisted Pair (UTP) as specified.

- a. Cable shall meet or exceed the approved TIA/EIA-568-B.2-1 Category 6A Unshielded Twisted Pair (UTP) cable standard for 24AWG four pair Category 6A cable.
- b. Acceptable equal cables shall be General Cable Command LINX 6; and GenSPEED 6000 Category 6A cables.
- c. Plenum rated cable - CMP rated jacket for Plenum applications.

E. Cable Management

1. Each equipment rack and equipment cabinet shall have cable management panels with horizontal and vertical brackets.
  - a. Cable management shall be EIA 19 inch (518mm) rack mounted 3.5 inch (88mm) high panel with horizontal and vertical patch cable, distribution rings, or approved equivalent and shall be provided above and below each patch panel in the equipment rack.
  - b. Equipment rack cable management shall be furnished by patch panel manufacturer.
  - c. Cable management for high density, IDC Type cross-connect block panels shall be distribution rings integral to the panel or approved equivalent. Cable management shall be provided above and below each cross connect block in the equipment rack.

F. Modular Jacks

1. Jacks shall be TIA/EIA Category 6A (UL Category 6A) with printed circuit board technology and integral board mounted, color-coded, high density, IDC type terminations. Provide 8 position modular jacks. Keyed jacks are not allowed. Jacks shall be able to withstand at least a minimum of 2000 mating cycles without any transmission degradation.
2. Modular jacks color shall be red.
3. Each 8-position modular jack shall have color-coded icons.
4. Modular jacks that allow pre-connectorized cables to be connected to the jacks are specifically prohibited. Cables shall have single point IDC Type connection to the jacks only.
5. Jack modules shall be flame retardant thermoplastic with integral cable strain relief. Color shall match faceplate.

G. Data Patch Panels for Security

1. Patch panels shall be EIA nineteen inch (518mm), rack mounted, TIA/EIA Category 6A, UL Category 6A type patch panels with integral printed circuit board, color-coded, high density, IDC type terminations and 8 position modular jacks. Keyed jacks are not allowed. Jacks shall be able to withstand at least a minimum of 2000 mating cycles without any transmission degradation.
2. Provide high density rack mounted patch panels.
3. Modular Jacks that allow pre-connectorized cables to be connected to the jacks are specifically prohibited. Cables shall have single point IDC type connection to the jacks only.
4. Each port shall have color-coded identification label. Continuous label strips for multiple in-line ports are acceptable. Silk screened identifiers "1" through "96" are acceptable.

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5. Patch panel shall have horizontal strain relief bar on mounted rear.
  6. Data Port Labeling Standard
    - a. <Closet>-<Patch Panel>-<Cable Purpose><Patch Panel Port Number>  
For Example: 3330-B-D43, This signifies that IDF Room 3330 Panel B on Data Patch Panel port 43
  - H. Patch Cables and Line Cords
    1. Patch cables and line cords shall be factory pre-connectorized, TIA/EIA Category 6A (UL Category 6A), 4 UTP, 8-position modular jack, stranded conductors. Patch cables and line cords shall be able to withstand at least a minimum of 2000 jack mating cycles without any transmission degradation.
  - I. Cross Connect Cabling
  - J. Cross-connect cabling shall be NRTL certified that it meets or exceeds the TIA/EIA UL category rating of the system installed.

## 2.7 INTEGRATED ELECTRONIC SECURITY SYSTEM, IESS

### A. Overview

1. The IP Integrated Electronic Security System shall be a truly integrated platform in terms of both hardware and software. This means that the software shall be an all inclusive package with only one application necessary to view and operate the IP CCTV cameras as well as the access control system and intrusion system. Video badging integration and graphic map GUI shall be included. Any system that requires the operator to use multiple programs on the same workstation will not be acceptable. The system specified is based upon S2. The school district currently utilizes this system will be an extension of the existing district wide IESS System and is proprietary.  
  
All systems referenced below shall be connected to a stand alone, dedicated security network as provided by the General Contractor (GC).
  - a. Unified IP CCTV Video
  - b. Access control network controllers and associated items.
  - c. Addressable Intrusion Alarm System
  - d. Servers and Workstations
  - e. Network Electronics
2. Manufacturers: S2 (Proprietary)
3. The Installing Contractor shall meet all qualifications as defined within this specification.
4. Integration between the IP Video, Access control and Intrusion alarm system is defined as follows:
  - a. Each door contact, motion detector, panic button, shall be individually annunciated on the Unified Security Platform GUI.

- b. The ACS shall support integration with the IP Video Surveillance System. Integration with the IP video surveillance system shall permit the user to view live and recorded video from one GUI and one single window. The same GUI shall be utilized for both the access control solution and the specified video surveillance solution. Switching from one application or GUI to another shall not be acceptable as well as utilizing two applications simultaneously to achieve the functionality specified is not allowed.
- 5. Access Control System Lockdown, Duress Functions and Shelter In Place
  - a. System shall be capable of programming the following features:
    - 1) Lockdown: Example of features that may be used:
      - a) Access Controlled Doors that are normally open (no credential needs to be presented to the card read) are secured (an employee must present their credential to the card reader).
      - b) Specific readers can be engaged (doors to interior office areas, all exterior doors secure, etc.)
      - c) Only specific credentials would be accepted by a card reader to unlock.
    - 2) Duress
      - a) Ensure a safe and effective manner of alerting onsite security personnel and staff members of an emergency (ie. medical emergency, irate parent or staff members, etc)
      - b) Deliver accurate indoor positioning data at the exact location of the individual in need of assistance.
    - 3) Shelter In Place

**B. VIDEO STORAGE PARAMETERS**

- 1. The quantity of TB and archivers shall be based on the following requirements.
  - a. 45 days of storage
  - b. 15 frames per second per camera
  - c. Max resolution each camera can support
  - d. Record on motion at 12 hours per day of motion
  - e. Video storage servers shall be HP or approved equal.

**C. HARDWARE AND SOFTWARE REQUIREMENTS**

- 1. Core and Edge Network Switch
  - a. Provide Power over Ethernet (PoE) network switch(s) for all cameras, access control panels, encoders/decoders, security workstations, video servers, and access control servers.
  - b. Each switch shall have 20 percent spare capacity per closet/IDF/MDF.
  - c. Each closet shall support 10/100mbs per port with a minimum of 1000GB on the back bone/core switch. The fiber infrastructure shall be only utilized for connectivity from each IDF to the MDF/core switch. The use of any portion of the copper back bone shall not be allowed.
  - d. Provide a layer 3 core switch which shall support each IDF/remote security closet with 1000gbs bandwidth over the fiber infrastructure. In addition to the support of each closet, provide a dedicated 1000gbs for each server (access control and video). Provide 20 percent 1000gbs copper ports and 20 percent spare 1000gbs fiber ports at the core switch/head end.

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- e. PoE network switches must support by same manufacturer a redundant power supply option. Though not a requirement at this time, proposed network switches must have this option without replacement of network switches.
  - f. Provide Uninterruptible Power Supply (UPS) for each closet/IDF/MDF to support the network PoE Switches. Provide a 1500VA UPS in each rack that houses security equipment. Each network switch shall be located in each IDF/MDF as required by the integrator.
  - g. Provide HPseries (no substitutions allowed) or approved equal for the core switch in MDF. Provide fiber GBIC cards and module as required to support each IDF and/or security closet as shown on the drawings and riser diagram.
  - h. Provide HP series (no substitutions allowed) for each edge switch. Each switch shall include a minimum of one (1) fiber GBIC card and module.
  - i. Provide an interface to the owner's LAN as required.
- D. Interior/Exterior Fixed Megapixel Vandal Dome Camera
- 1. Provide cameras with the following specifications for all indoor/outdoor fixed cameras as shown on the drawings. Provide exterior model for all exterior cameras.
    - a. Image sensor: Progressive Scan RGB CMOS 1/3.2"
    - b. Lens: Vari-focal, DC iris. Provide either 6mm or 12mm. The lens shall be selected based on the location of the camera and desired field of view. This should be documented in the submittals.
    - c. Day/Night
    - d. Shutter time: 1/28000 s to 2s
    - e. Resolution: 5 megapixel
    - f. Digital PTZ functions
    - g. Video compression: H.264 and Motion JPEG
    - h. Frame rate per camera: Can support up to 30 fps.
    - i. Video streams: Multiple, individually configurable
    - j. Audio streaming: Two-way
  - 1. The power source shall be Power over Ethernet (IEEE 802.3af).
  - 2. Provide Axis P3367-V or approved equal for all interior cameras.
  - 3. Provide Axis P3367-VE for all exterior fixed cameras. Provide with wall/corner mounts where required.
- E. IP MULTI-SENSOR 180 DEGREE MEGAPIEL FIXED CAMERA [Basis of Design Axis P3807-PVE]
- 1. Fixed dome multi-sensor panoramic network camera
    - a. The fixed dome multi-sensor network camera shall meet or exceed the following design specifications:
      - 1) The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
      - 2) The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.

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- 3) The camera shall provide an automatically removable IR-cut filter, providing day/night functionality.
  - 4) The camera shall be manufactured with an IP66/IP67 and NEMA 4X-rated, IK10 impact-resistant aluminum casing fitted with a repaintable weather shield.
  - 5) The camera shall be equipped with 3,2 mm fixed lenses providing a
    - a) Horizontal field of view: 180°
    - b) Vertical field of view: 90°
  - 6) The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
  - 7) The camera shall provide a 180° panoramic overview provided by four sensors.
- b. The fixed dome multi-sensor network camera shall meet or exceed the following performance specifications:
- 1) Illumination
    - a) The camera shall meet or exceed the following illumination specifications:
      - 0.17 lux in color
      - 0.05 lux B/W
  - 2) Resolution
    - a) Be designed to provide video streams in:
      - 8.3 MP: up to 25/30 fps with power line frequency 50/60 Hz
      - 7.5 MP (dewarped): up to 12.5/15 fps with power line frequency 50/60 Hz
    - b) The individual cameras shall support video resolutions including:
      - 1920x1080 (HDTV 1080p)
      - 1280x720 (HDTV 720p)
  - 3) Encoding
    - a) The camera shall support the following video encoding algorithms:
      - Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second in all resolutions.
      - Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
      - Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
      - Support High Profile H.264 encoding with motion estimation up to 50/60 frames per second.
    - b) The camera shall provide two independently configured simultaneous H.264 and Motion JPEG streams.

- c) The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
  - d) The camera shall provide configurable compression levels.
  - e) The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
- 4) Transmission
- a) The camera shall allow for video to be transported over:
    - HTTP (Unicast)
    - HTTPS (Unicast)
    - RTP (Unicast & Multicast)
    - RTP over RTSP (Unicast)
    - RTP over RTSP over HTTP (Unicast)
  - b) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- 5) Image
- a) The camera shall incorporate automatic and manual white balance.
  - b) The camera shall incorporate an electronic shutter operating in the range of 1/33500s to 1/10 s.
  - c) The camera shall incorporate forensic wide dynamic range functionality, providing up to 120 dB dynamic range.
  - d) The camera shall support manually defined values for:
    - Saturation
    - Contrast
    - Sharpness
    - Brightness
  - e) The camera shall incorporate a function for optimization of low light behavior.
- 6) User Interface
- a) Web server
    - The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
    - Optional components downloaded from the camera for specific tasks shall be signed by an organization providing digital trust services, such as Verisign, Inc.
  - b) Language Specification
    - The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.



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- c) IP addresses
    - The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
    - The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
    - The camera shall provide support for IPv6.
  - 7) Event functionality
    - a) The camera shall be equipped with an integrated event functionality:
      - Detectors functionality
    - b) Video motion detection
    - c) Shock detection
      - Hardware functionality
      - Input Signal functionality
    - d) External input
    - e) Manual trigger / virtual Inputs
    - f) Camera tampering
      - Storage functionality
      - System functionality
    - g) Embedded third-party applications
    - h) Edge storage fail-over recording detection
    - i) Response to triggers shall include:
      - Send notification, using HTTP, HTTPS, TCP or email
      - Send images, using FTP, SFTP, HTTP, HTTPS, network share or email
      - Send video clip, using FTP, SFTP, HTTP, HTTPS, network share or email
      - Send SNMP trap message
      - Recording to local storage and/or network attached storage
      - Day/Night Vision Mode
      - Overlay Text
    - j) The camera shall provide memory for pre & post alarm recordings.
  - 8) Edge storage
    - a) The camera shall support continuous and event controlled recording to:
      - Local memory added to the cameras microSD-card slot
      - Network attached storage, located on the local network.
    - b) The camera shall incorporate encryption functionality for the SD card.

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- c) The camera shall be able to detect and notify edge storage disruptions.
  - 9) Protocol
    - a) The camera shall incorporate support for at least IPv6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, LLDP
    - b) The SMTP implementation shall include support for SMTP authentication.
  - 10) Text overlay
    - a) The camera shall:
      - Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
      - Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
      - Provide the ability to manually set up and configure privacy masks to the image.
      - Allow for the overlay of a graphical image, such as a logotype, into the image.
  - 11) Security
    - a) The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
    - b) The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
    - c) The camera shall support IEEE 802.1X authentication.
    - d) The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
    - e) The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.
  - 12) API support
    - a) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
    - b) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
    - c) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
  - 13) Embedded applications
    - a) The camera shall provide a platform allowing the upload of third-party applications into the camera.

- 14) Installation and maintenance
  - a) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
  - b) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
  - c) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
  - d) The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
  - e) The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
  - f) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- 15) Access log
  - a) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
  - b) Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- 16) Camera diagnostics
  - a) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
  - b) The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
  - c) The camera shall send a notification when the unit has re-booted and all services are initialized.
- 17) Hardware interfaces
  - a) Network interface
    - The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T Ethernet-port using a RJ45 connector, and shall support auto negotiation of network speed and transfer mode (full and half duplex).
- 18) Enclosure
  - a) The camera shall:
    - Be manufactured with an IP66-/IP67- and NEMA 4X-rated, IK10-rated impact-resistant casing with polycarbonate hard coated clear dome.
    - Be fitted with a dehumidifying membrane.

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- 19) Power
    - a) Power over Ethernet Plus (PoE+) IEEE 802.3at Type 1 Class 3
      - Max: 12.9 W
      - Typical: 7 W
  - 20) Environmental
    - a) Operate in a temperature range of -30 °C to 50 °C (-22 °F to 122 °F).
    - b) Operate in a maximum temperature (intermittent) of 60 °C (140 °F)
    - c) Operate in a humidity range of 10 -100% RH (condensing).
- F. IP MULTI-SENSOR 360 DEGREE MEGAPIEL FIXED CAMERA [Basis of Design Axis P3707-pve]
1. Panoramic network camera
    - a. The panoramic network camera shall meet or exceed the following design specifications:
      - 1) The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
      - 2) The camera shall be equipped with four progressive scan megapixel sensors.
      - 3) The camera shall provide flexible positioning of four varifocal camera heads.
      - 4) The camera shall provide the following field of view:
        - a) 4x 1080p
          - Horizontal: 108° - 54°
          - Vertical: 57° - 30°
        - b) 4x 720p
          - Horizontal: 67° - 36°
          - Vertical: 37° - 20°
      - 5) The camera shall provide adjustable focus and zoom functionality.
      - 6) The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
      - 7) The camera shall be manufactured with an IP66-, NEMA 4X- and IK09-rated Die-casted aluminum casing.
      - 8) The camera shall provide:
        - a) Pan ± 90°
        - b) Tilt 28° - 92°
        - c) Rotate ± 90°
    - b. The panoramic network camera shall meet or exceed the following performance specifications:
      - 1) Illumination
        - a) The camera shall meet or exceed the following illumination specifications:
          - 0.3 lux in color

- 2) Resolution
  - a) The camera shall be designed to provide 4x video streams in HDTV 1080p (1920x1080) at up to 15 frames per second (60Hz mode) or 12.5 frames per second (50Hz mode) using H.264 or Motion JPEG.
  - b) The camera shall be designed to provide 4x video streams in HDTV 720p (1280x720) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.
  - c) The camera shall be designed to provide quad view in resolution up to 1920x1440
  - d) The camera shall support video resolutions including:
    - 1920x1440 (Quad view)
    - 1920x1080 (HDTV 1080p)
    - 1280x720 (HDTV 720p)
  - e) The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).
- 3) Encoding
  - a) The camera shall support the following video encoding algorithms:
  - b) Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second in all resolutions.
  - c) Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
  - d) Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
  - e) Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
  - f) Support H.264 with automatic scene adaptive bitrate control in up to 25/30 frames per second.
  - g) The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
  - h) The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
  - i) The camera shall provide configurable compression levels.
  - j) Support standard baseline profile H.264 with motion estimation.
  - k) Support motion estimation in H.264/MPEG-4 Part 10/AVC.
  - l) The camera shall for its H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- 4) Transmission
  - a) The camera shall allow for video to be transported over:
    - HTTP (Unicast)
    - HTTPS (Unicast)
    - RTP (Unicast & Multicast)
    - RTP over RTSP (Unicast)
    - RTP over RTSP over HTTP (Unicast)

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- b) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
  - 5) Image
    - a) The camera shall incorporate Automatic and Manual White Balance.
    - b) The camera shall incorporate an electronic shutter operating in the range of:
      - 720p: 1/28000 s to 2 s
      - 1080p: 1/22500 s to 2 s
    - c) The camera shall incorporate capture mode with the following settings:
      - HDTV 1080p 12.5/15 fps
      - HDTV 720p 25/30 fps
    - d) The camera shall support manually defined values for:
      - Color level
      - Brightness
      - Sharpness
      - Contrast
    - e) The camera shall incorporate a function for optimization of low light behavior.
    - f) The camera shall allow for rotation of the image in steps of 90°.
    - g) The camera shall incorporate local contrast functionality.
  - 6) User Interface
    - a) Web server
      - The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
      - Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
    - b) Language Specification
      - The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
    - c) IP addresses
      - The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
      - The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
      - The camera shall provide support for both IPv4 and IPv6.
  - 7) Event functionality
    - a) The camera shall be equipped with an integrated event functionality, which can be triggered by:
      - Video Motion Detection
      - Live Stream Accessed
      - Camera tampering
      - Manual Trigger/Virtual Inputs
      - Embedded third party applications

- Edge storage disruption detection
  - b) Response to triggers shall include:
    - Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
    - Send images, using FTP, HTTP, HTTPS, network share or email
    - Send video clip, using FTP, HTTP, HTTPS, network share or email
    - Recording to local storage and/or network attached storage
    - Overlay Text
  - c) The camera shall provide memory for pre & post alarm recordings.
- 8) Edge storage
- a) The camera shall support continuous and event controlled recording to:
    - Local memory added to the cameras SD-card slot
    - Network attached storage, located on the local network
  - b) The camera shall be able to detect and notify Edge storage disruptions.
- 9) Protocol
- a) The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
  - b) The SMTP implementation shall include support for SMTP authentication.
- 10) Text overlay
- a) The camera shall:
    - Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
    - Provide the ability to apply privacy masks to the image.
    - Allow for the overlay of a graphical image, such as a logotype, into the image.
- 11) Security
- a) The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
  - b) The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
  - c) The camera shall support IEEE 802.1X authentication.
  - d) The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
  - e) The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.

- 12) API support
  - a) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
  - b) The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.
- 13) Embedded applications
  - a) The camera shall provide a platform allowing the upload of third party applications into the camera.
- 14) Installation and maintenance
  - a) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
  - b) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
  - c) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
  - d) The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
  - e) The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
  - f) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- 15) Access log
  - a) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
  - b) Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- 16) Camera diagnostics
  - a) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
  - b) The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
  - c) The camera shall send a notification when the unit has re-booted and all services are initialized.



- 17) Hardware interfaces
  - a) Network interface
    - The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Fast Ethernet-port, using a standard male RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
- 18) Enclosure
  - a) The camera shall:
    - Be manufactured with an IP66-, NEMA 4X- and IK09-rated Die-casted aluminum casing.
    - Be fitted with a polycarbonate dome.
- 19) Power
  - a) Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 2
  - b) Typical 4.8 W
  - c) Max 5.5 W
- 20) Environmental
  - a) Operate in a temperature range of -30 °C to +60 °C (-22 °F to 140 °F).
  - b) Operate in a humidity range of 10–100% RH (condensing).

G. CAMERA – PAN, TILT AND ZOOM (PTZ) [Basis of Design Axis Q6055E]

1. Exterior 1080p network PTZ camera
  - a. The PTZ network camera shall meet or exceed the following design specifications:
    - 1) The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
    - 2) The camera shall provide a removable IR-cut filter, providing day/night functionality.
    - 3) The camera shall provide autofocus functionality.
    - 4) The camera shall provide auto-iris functionality.
    - 5) The camera shall provide local video storage utilizing a SD/SDHC/SDXC memory card expansion.
    - 6) The camera shall be manufactured with an IP66 and NEMA 4X rated metal casing (aluminum).
  - b. The PTZ network camera shall meet or exceed the following performance specifications:
    - 1) Illumination
      - a) The camera shall meet or exceed the following illumination specifications:
        - Color: 0.3 lux at 30 IRE F1.6
        - B/W: 0.03 lux at 30 IRE F1.6
        - Color: 0.5 lux at 50 IRE F1.6
        - B/W: 0.04 lux at 50 IRE F1.6
    - 2) Resolution
      - a) The camera shall be designed to provide video streams in HDTV 1080p (1920x1080) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.

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- b) The camera shall be designed to provide video streams in HDTV 720p (1280x720) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264 or Motion JPEG.
  - c) The camera shall support video resolutions including:
    - 1920x1080 (HDTV 1080p)
    - 1280x720 (HDTV 720p)
- 3) Encoding
- a) The camera shall support the following video encoding algorithms:
    - Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second (1080p).
    - Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second (720p).
    - Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second (1080p).
    - Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second (720p).
    - Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second (1080p).
    - Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 50/60 frames per second (720p).
    - Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second (1080p).
    - Support High Profile H.264 encoding with motion estimation up to 50/60 frames per second (720p).
    - Support H.264 with automatic scene adaptive bitrate control.
  - b) The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
  - c) The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
  - d) The camera shall provide configurable compression levels.
  - e) Support standard baseline profile H.264 with motion estimation.
  - f) Support motion estimation in H.264/MPEG-4 Part 10/AVC.
  - g) The camera shall for its H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- 4) Transmission
- a) The camera shall allow for video to be transported over:
    - HTTP (Unicast)
    - HTTPS (Unicast)
    - RTP (Unicast & Multicast)
    - RTP over RTSP (Unicast)
    - RTP over RTSP over HTTP (Unicast)
  - b) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.

- 5) Image
  - a) The camera shall incorporate Automatic and Manual White Balance.
    - The camera shall incorporate an electronic shutter operating in the range of:
    - 1/33000 s to 1/3 s (50 Hz)
    - 1/33000 s to 1/4 s (60 Hz)
  - b) The camera shall incorporate Wide Dynamic Range functionality providing up to 120 dB dynamic range.
  - c) The camera shall provide backlight compensation functionality.
  - d) The camera shall support manually defined values for:
    - Color level
    - Brightness
    - Sharpness
    - Contrast
  - e) The camera shall incorporate a function for optimization of low light behavior.
  - f) The camera shall allow for rotation of the image.
  - g) The camera shall provide Highlight compensation.
  - h) The camera shall incorporate automatic defog functionality.
    - User Interface
  - i) Web server
    - The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
    - Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
  - j) Language Specification
    - The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
  - k) IP addresses
    - The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
    - The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
    - The camera shall provide support for both IPv4 and IPv6.
- 6) PTZ functionality
  - a) The camera shall:
    - Provide more than 255 manually set preset positions.
    - Provide e-flip functionality, which will automatically rotate the image 180° electronically when following a moving object passing under the camera.
    - Provide On-screen directional indicator (OSDI) functionality.
    - Be able to record a custom PTZ tour, operated using an input device such as a joystick, mouse or keyboard, and then use and recall this as a guard tour.

- Be able to detect and automatically follow moving objects in the cameras field of view.
  - Be equipped with accurate high-speed pan-tilt functionality with 360° endless pan range and a 220° tilt range.
  - Provide pan and tilt speed between 0.05° - 450°/sec.
  - Provide 32x optical zoom.
  - Provide 12x digital zoom.
  - Provide adjustable zoom speed.
- 7) Event functionality
- a) The camera shall be equipped with an integrated event functionality, which can be triggered by:
- Live stream accessed
  - Video Motion Detection
  - Shock detection
  - Fan malfunctioning
  - Enter/Exit
  - Fence Detector
  - Object Removed
  - Object Counter
  - Temperature
  - Manual trigger/virtual inputs
  - PTZ functionality
  - External input
  - Embedded third party applications
  - Edge storage disruption detection
- b) Response to triggers shall include:
- Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
  - Send images, using FTP, HTTP, HTTPS, network share or email
  - Send video clip, using FTP, HTTP, HTTPS, network share or email
  - Send SNMP trap message
  - Day/Night Vision Mode
  - Overlay Text
  - Recording to local storage and/or network attached storage
  - Activating external output
  - PTZ control functionality
- c) The camera shall provide memory for pre & post alarm recordings.
- 8) Edge storage
- a) The camera shall support continuous and event controlled recording to:
- Local memory added to the cameras SD-card slot
  - Network attached storage, located on the local network
- b) The camera shall be able to detect and notify Edge storage disruptions.

- 9) Protocol
  - a) The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, NTCIP, Bonjour.
  - b) The SMTP implementation shall include support for SMTP authentication.
- 10) Text overlay
  - a) The camera shall:
    - Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
    - Provide the ability to apply up to 32 individually set 3D privacy masks to the image.
    - Allow for the overlay of a graphical image, such as a logotype, into the image.
- 11) Security
  - a) The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
  - b) The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
  - c) The camera shall support IEEE 802.1X authentication.
  - d) The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
  - e) The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.
- 12) API support
  - a) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
  - b) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
  - c) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
    - For ONVIF profile specifications, see [www.onvif.org/](http://www.onvif.org/)
- 13) Embedded applications
  - a) The camera shall provide a platform allowing the upload of third party applications into the camera.
- 14) Installation and maintenance
  - a) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
  - b) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
  - c) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.

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- d) The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
  - e) The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
  - f) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- 15) Access log
- a) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
  - b) Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
  - c) Camera diagnostics
  - d) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
  - e) The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
  - f) The camera shall send a notification when the unit has re-booted and all services are initialized.
- 16) Hardware interfaces
- a) Multifunctional connector
    - The camera shall, by using a "multi wire cable", provide connectivity for:
  - b) RJ45 - 10BASE-T/100BASE-TX
  - c) I/O
  - d) DC power
- 17) Enclosure
- a) The camera shall:
    - Be manufactured with an IP66 and NEMA 4X rated metal casing (aluminum)
    - Be fitted with an sunshield
    - Be fitted with Temperature sensors
    - Be fitted with a fan
- 18) Power
- a) 24 V DC
    - Max: 75 W
    - Minimum: 65 W
- 19) Environmental
- a) The camera shall:
    - Operate in a temperature range of -20 °C to 75 °C (-4 °F to 167 °F).
    - Operate in a humidity range of 10–100% RH (condensing).

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4. Install the MIDSPAN POE Injector that is provided with the Camera in the box, and as instructed by Axis Communications to mitigate low temperatures.
  5. General Standards & Requirements:
    - a. The camera shall be manufactured with an all- metal body, support operation between -20°C to +50°C (-4°F to +122°F) and be both IP66 and NEMA 4X certified.
    - b. The camera shall be equipped with a progressive scan sensor, 32x optical or better zoom, so called Day/Night functionality and shall provide images down to 0.5 lux in day mode and 0.01 lux in night mode.
    - c. The camera shall provide accurate high-speed pan-tilt functionality with 360° pan range and a 180° tilt range, provide pan and tilt speed between 0.2° - 200°/sec, be equipped with Auto-flip and incorporate at least 100 presets.
    - d. The camera shall be equipped with a 10BASE-T/100BASE-TX Ethernet-port, and shall include support for High Power over Ethernet according to IEEE 802.3at.
    - e. The camera shall provide simultaneous Motion JPEG and H.264 video streams and shall support at least three individually configured video streams of resolutions up to 720x480 (60Hz) / 720x576 (50Hz) pixels in full frame rate (30/25fps). The H.264 implementation shall include both unicast and multicast functionality and support Constant Bit Rate (CBR) as well as Variable Bit Rate (VBR).
    - f. The camera shall be able to trigger its embedded event functionality based on detection of video motion, PTZ position, when the local storage is full, camera temperature or in the case of fan malfunctions. Possible response to a triggered event shall include remote notification, incl. video upload, preset call-up and recording to local storage. The camera shall be equipped with a video buffer for saving pre- and post-alarm images and shall have a SD/SDHC card slot to support local storage of video.
    - g. The camera shall feature overlay text ability, that includes date and time synchronized using an NTP server. Furthermore, it shall have the ability to apply a graphical image as an overlay and at least 4 individually configurable and dynamically adjusted privacy masks in the video stream.
    - h. The camera shall support both static IP addresses and addresses from a DHCP-server, and shall support both IPv4 and IPv6. The camera shall incorporate support for Quality of Service (QoS).
    - i. For secure access to the camera as well as provided content, the camera shall support HTTPS, SSL/TLS and IEEE802.1X authentication. The camera shall also support IP address filtering and include at least three different levels of password security.
    - j. The camera shall contain a built-in web server making video and configuration available in a standard browser environment using HTTP and shall also be fully supported by an open and published API (Application Programmers Interface) providing necessary information for integration of functionality into third party applications.
    - k. The camera shall conform to the network video standard as defined by the ONVIF organization.

6. The camera shall:
  - a. Be manufactured with an all-metal body
  - b. Be both IP66 and NEMA 4X-rated
  - c. Start-up and operate between -20°C to +50°C (-4°F to +122°F)
  - d. Be equipped with a 10BASE-T/100BASE-TX Ethernet interface
  - e. Be equipped with a progressive scan sensor and provide images down to 0.5 lux in day mode and 0.01 lux in night mode
  - f. Be equipped with 18x optical zoom and so called Day/Night functionality
  - g. Provide at least 3 streams of resolutions up to 720x480 (60Hz) / 720x576 (50Hz) pixels at 30/25 frames per second per stream
  - h. Support simultaneous individually configured Motion JPEG and H.264 video streams
  - i. Support both unicast and multicast H.264 with support for both Constant and Variable Bit Rate
  - j. Support Power over Ethernet according to IEEE 802.3at
  - k. Accept static IP addresses as well as addresses provided by a DHCP
  - l. Support both IPv4 and IPv6 based addresses
  - m. Provide accurate high-speed pan-tilt functionality with 360° pan range and a 180° tilt range
  - n. Provide pan and tilt speed between 0.2° - 200°/sec
  - o. Be equipped with Auto-flip and incorporate at least 100 presets
  - p. Provide text overlay that includes date/time support synchronized with an NTP server and the ability to apply a graphical image as an overlay into the video image
  - q. Provide multiple user password levels, support for HTTPS and SSL/TLS and incorporate IEEE 802.1X authentication
  - r. Be equipped with four I/O ports, configurable as in- or output
  - s. Be equipped with an SD/SDHC memory card slot
  - t. Include embedded event functionality, which may be triggered by:
    - 1) video motion detection
    - 2) PTZ position
    - 3) camera temperature outside of operative range
    - 4) fan malfunction
    - 5) local storage full



- u. Event actions supported by the camera shall include:
  - 1) remote notification, including video upload
  - 2) preset call-up
  - 3) recording to local storage
- v. Be equipped with a built-in web server
- w. Be supported by an open and published API
- x. Be conformant to the network video standard as defined by the ONVIF organization
- 2. Exterior Camera Fiber Transceivers (required when pole mounting cameras remotely from the main building)
  - a. Provide fiber optic transceivers for all pole mounted and remote building mounted cameras. Transceivers shall be located at the base of the pole in a NEMA rated heated, lockable enclosure. Paint enclosure to match pole.
  - b. Provide American Fibertek MX2-MM-FX or equal media converters as required for each camera. Transmitter shall be located in NEMA rated enclosure at the pole. Receiver shall be located in the security rack.
  - c. Provide Altronix T2428100WP or equal outdoor rated power supply for each camera, located at the pole. Power supply shall be located in NEMA rated enclosure at the pole.
- 3. Auxiliary Power supply
  - a. Provide a UL listed 12/24 auxiliary power supply with cabinet and batteries to support miscellaneous devices such as: long range readers, fiber transceivers, REX sensors, horns/beacons, motion detectors, etc.
  - b. Provide Altronix or approved equal.
- 4. Card Reader
  - a. Provide smartcard readers as shown on the drawings.
  - b. The reader shall have a 26-bit Weigand output.
  - c. The reader shall transmit on 13.56 MHz frequency.
  - d. The readers shall include a piezo buzzer and bi-color LED.
  - e. The reader shall be suitable for indoor and outdoor applications.
  - f. The reader shall operate up to 1000ft on 22AWG 3 twisted pair cable.
  - g. Snap and lock terminal block.
  - h. Provide with keypad where specifically shown.
  - i. Provide combination Card reader/keypad HID R40 or approved equal. Provide R10 for mullion mount applications.
  - j. Card reader shall have same characteristics as existing police station.
- 5. Long Range Reader
  - a. Provide long range reader at Parking Garage entrance.
  - b. The reader shall transmit between 865 - 868 MHz / 902 - 928 MHz.
  - c. The reader shall be suitable for outdoor applications.
  - d. Up to 5 meter read range.

- e. Provide with polycarbonate housing to mount to stanchion/wall bracket. Stanchion/wall bracket by others.
  - f. Provide HID SE U90 or approved equal.
6. Cards
- a. Provide multi technology UHF/iClass credentials.
  - b. Credentials must be able to function with both the standard readers and gate reader.
  - c. Provide HID 601 or approved equal.
  - d. Provide 500.
7. Door Contacts
- a. Furnish and install 3/4 in. recessed magnetic door contacts as shown on the drawings.
  - b. Provide Sentrol/GE 1076C or equal dual output door contact or equal unless noted below.
  - c. Provide DPDT contacts for all doors. The second pole will be wired and connected to the intrusion alarm system addressable module.
8. Request-to-exit devices
- a. Furnish and install motion request-to-exit sensors as shown on the drawings and as required. Utilize doors that have hardware which have integral request-to-exit switches as required. Coordinate with door hardware.
  - b. Provide DS 150i or approved equal with trim plate if required to mount above the door.
9. Electric strike/magnetic locks power supply
- a. Electric strikes and magnetic locks power supplies as needed and required shall be furnished by the door hardware provider. Installed and wired by the electrical contractor, connected to IESS by Security Contractor.
10. Locking Devices (Electric strike/Magnetic locks/Electric locks/Electric Hinges)
- a. Furnished and installed by others. Installed and wired by the electrical contractor.
11. Video Intercom Unit
- a. Direct network connection with Static or Dynamic IP
  - b. Full open duplex communications
  - c. Power over Ethernet (POE) supported
  - d. Rugged 11 gauge stainless steel faceplate
  - e. True tamper resistant construction
  - f. Rugged call button
  - g. Weather resistant
  - h. Sensitive electret microphone
  - i. Mounts in industry standard 3 gang switch backbox
  - j. Mic Open LED
  - k. Full Supervision (speaker, microphone, station electronics, cable, network)

- l. Wide angle camera (up/down angle adjustable)
  - m. Camera resolution of 1MP.
  - n. Provide Commend ES931ACW with custom recessed backbox or approved equivalent. Any equivalent manufactures must be fully compatible with the Unified Security platform.
  - o. Provide with Unified Security system license.
12. Duress Stations
- a. Provide remote duress panic switch as shown on the drawings. Each duress button shall be wired to the intrusion panel via addressable module for camera call-up and general alarm conditions. Each button shall report and be programmed independently of one another.
  - b. Provide Sentrol 3045 or approved equal.
13. Battery backup
- a. Provide battery backup of all servers, workstations, network controllers, network switches, auxiliary power supplies and intrusion panel.
  - b. Provide rack mount UPS units for all rack mount security equipment and floor mounted for all workstations.
  - c. Provide a minimum of 10 minutes backup.
  - d. Provide APC or approved equal.
14. Intrusion Alarm Control Panel
- a. Provide an intrusion system as required and as shown on the plans. The cost of monitoring the facility at a UL listed central station shall be included for a period of one year. Arrange account information with the building owner at the time of setup.
  - b. The intrusion alarm panel shall be fully integrated to the USP. Include integration module for network connection to the access control system for full software integration.
  - c. Provide all labor, materials, equipment, and services to perform all operations required for the complete installation and related work as shown in all contract documents.
  - d. All motion detectors, roof hatches and exterior doors shall report and be individually annunciated on the intrusion alarm LCD system keypad and access control system. Corridor motions sensors shall be individually addressable. Classroom motions sensors shall be grouped within each section to an addressable input module. LCD keypads shall be able to arm and disarm the intrusion alarm system and shall allow for system programming.
  - e. Once armed, any motion detector, door contact, and glass break shall both cause the audible sounder to sound and call the central station.
  - f. The control panel shall be capable of supporting Dynamic Host Communication Protocol (DHCP) Internet Protocol (IP) addressing.
  - g. The control panel shall be capable of two-way network communication using standard Ethernet 10BaseT in a LAN, WAN, or Internet configuration.
  - h. Provide an addressable intrusion alarm control panel complete with enclosure, power supply, and door lock.

- i. The panel must support up to 240 addressable points.
  - j. The panel must be able to support 8 independent partitions.
  - k. Provide with battery back up and battery harness for a minimum of 4 hours.
  - l. Provide DMP XRN series or approved equal.
15. Intrusion Alarm Keypad
- a. Provide 2-Line, 32-character platinum keypad as shown on the drawings.
  - b. The keypads can be used to both arm and disarm the intrusion system.
  - c. Shall include backlighting, display of zone status, system status, trouble conditions, event buffer, system instructions, date and time.
  - d. Provide DMP or approved equal.
16. PIR Motion Detectors / Addressable input points
- a. Provide addressable motion sensors (ceiling and wall mounted where shown). Sensors shall process their signals independently and shall have coverage patterns individually adjustable.
  - b. Each PIR shall be wired to the intrusion alarm system on an addressable loop. Include booster boards where necessary to ensure signal integrity.
  - c. Provide long range detectors as shown on the plans and as required.
  - d. Wiring connections shall be made in equipment cabinets. Conductors other than that of detector will not be allowed at each device. There shall be no exposed wiring leading to/from detectors.
  - e. Catalog, model and type numbers itemized herein for motion detectors are those of DSC.
  - f. Detectors shall be mounted on ceiling type wiremold box.
  - g. Fields of view that are directed at heat sources such as fans, radiators and other areas that may cause false alarms shall be masked out.
  - h. Provide DMP MX series wall and ceiling mount models utilizing multi-signal level processing or approved equal.
  - i. Provide addressable input module for door contacts and non-addressable devices – DMP Model 914 series or approved equal.
17. Door Contacts/switches
- a. Provide recessed door contacts/switches as shown on the drawings. Contacts shall be 3/4 inch and have wire leads of sufficient length for splices to be made in wiremold box or mud type box located adjacent to door. Provide GE model #1078C or approved equal for interior doors. Provide DPDT contacts for all exterior doors, GE model #1076-D or approved equal.
  - b. In event that circumstances prevent the use of recessed contacts in some locations, surface contacts may be used, subsequent to approval of Architect.
  - c. Wiring for door contacts shall be concealed.
  - d. Door contacts shall not be wired in series with exception of double doors which may be wired to panel as single door location.

- e. There shall be no splices in door frames or jambs. Door contact connections shall be made in wiremold or mud switch box located adjacent to door.
18. Overhead Door
- a. Provide overhead door contacts as shown on the drawings. Provide one zone input module per device.
  - b. Provide Sentrol 2200 series or approved equal.
19. Service, SMA and Preventative Maintenance Agreement
- a. The Systems Integrator shall perform quarterly and annual preventative maintenance services on all systems and equipment as specified in this section for a period of one year after substantial completion. Quarterly visits shall consist of workstation/server re-boots, network utilization reports, and workstation/server utilization reports. Annual visits shall consist of a Genetec software upgrade and any OS upgrades that are required as a result of the Genetec upgrade.
  - b. Include a one year manufactured approved software maintenance agreement for the entire IESS.
  - c. Components and parts that are found to be defective, have failed operationally or which exhibit signs of near term failure will be identified during each preventive maintenance inspection or test. If the component or part is covered under a current Systems Integrator or factory warranty, said part or component will be replaced at no charge to CUSTOMER including labor during normal business hours.
  - d. For any equipment requiring repair or replacement that is not covered, an estimate will be prepared and submitted for approval on a reimbursable basis and repair authorization shall be issued in writing by an authorized representative of the CUSTOMER before proceeding with the work.
20. Response Time
- a. Should an emergency arise, the Systems Integrator personnel will assess the situation either by phone or remote diagnostics, or both, and will determine the required course of action with the CUSTOMER.
  - b. On-Site Response Time: If it is determined that a site visit is required, the Systems Integrator personnel will arrive at the affected premises within four hours of the request of the CUSTOMER.
  - c. If the resolution of the emergency service call requires the Systems Integrator to provide service for equipment that is not listed in this specification section, CUSTOMER will be liable for charges and expenses prevailing for such service.
  - d. Emergency Service will be provided during the following periods.
    - 1) Provide Emergency Service Monday through Friday 8:00 AM – 5:00PM excluding evenings and weekends, city, state, federal and Systems Integrator observed holidays at no additional charge to the base annual service fee. Labor for travel time is included under this Agreement.
    - 2) The Systems Integrator will provide a response time as stated and agreed to above. Emergency Service requested by the CUSTOMER to be provided outside of the above stated times will be reimbursed by the CUSTOMER as shown below.

- e. Emergency Service during the following periods is not included.
  - 1) Emergency Service Monday through Friday 5:00PM – 8:00AM, weekends, city, state, federal and Systems Integrator observed holidays are not included. Emergency Services provided under this scope will be reimbursable by the CUSTOMER to the Systems Integrator at then current Systems Integrator published service labor rates and standard service charges (Minimum Labor Charge, Vehicle Charges, Round Trip Travel Time, Mileage).
- 21. Provide 8 hours of video taped training broken up into (2) 4 hour sessions. The training shall be done once the system is complete and operational and all programming is complete. The training shall include step by step instruction of the sequence of operation at each door type, moves adds, changes, and use of all supplied IESS equipment.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Do not install equipment and materials which have not been reviewed by the Architect. Equipment and materials which are installed without the Architect's review or without complying to comments issued with the review shall be removed from the project when so instructed by the Architect. No payment will be made for unapproved or removal if it is ordered removed. The Installer shall be responsible for any ancillary costs incurred because of its removal and the installation of the correct equipment and materials.

#### **3.2 EQUIPMENT RACKS, CABINETS AND BRACKETS**

- A. Securely mount equipment racks, cabinets and wall mounted relay brackets to the building structure. Proper supports such as 3/8" lag screws and expansion anchors shall be used. Proper quantity of supports shall be utilized. Dry wall screws and other types of supports not specifically approved to support equipment are specifically prohibited. Submit mounting supports for approval before installation.

#### **3.3 TERMINATIONS**

- A. All copper conductors of every cable shall be completely terminated at both ends.

#### **3.4 CABLE PATHWAYS**

- A. Install cables in pathways provided by the Electrical Subcontractor or required under execution part of this Section.

#### **3.5 SEALING OF PENETRATIONS AND OPENINGS**

- A. Environmental Seals
  - 1. Provide seals on raceways exposed to widely different temperatures, as in refrigerated or cold storage areas. Install seal to prevent circulation of air from warmer to colder sections through the raceway.

3.6 SEISMIC SUPPORTS, SUPPLEMENTARY STEEL AND CHANNELS

- A. Provide all supports, supplementary steel and channels required for the proper Seismic installation, mounting and support of all work installed under this Section.

3.7 CABLE SUPPORTS

- A. Provide strain relief hardware for backbone cables at each floor level as they pass from one floor to the next.

3.8 CABLE PROTECTION

- A. Provide bushings in all metal studs and the like where cables will pass through. Bushings shall be of two (2) piece construction with one piece inserted through the opening and the second piece locking it into place. Single piece bushings with locking tabs or friction fit are specifically prohibited.

3.9 INSTALLATION

- A. All cabling shall be installed in conduit where indicated on plans, or shall be installed open using other methods, approved by architect, such as J-Hooks.
  - 1. Install wiring, per manufacturers recommendations. Use UL listed plenum cable in environmental air spaces including plenum ceilings.

3.10 TRAINING

- A. As a minimum, training sessions shall consist of the following:
  - 1. General project information and review shall be by the General Foreman or Superintendent of the Trade.

3.11 ACCEPTANCE DEMONSTRATIONS

- A. Systems installed under this Section shall be demonstrated to the Owner and Architect. Demonstrations are in addition to necessary testing and training sessions. Notify all parties at least 7 days prior to the scheduled demonstration. Schedule demonstrations, in cooperation with and at times convenient to all parties, so as to not disturb ongoing activities.

3.12 PROJECT OWNER COORDINATION

- A. Prior to Substantial Completion of the project and in ample time to address and resolve any coordination issues, request and arrange meetings between the Owner, Owner's Vendors and Consultants, Architect and General Contractor to discuss the Scope of Work for each system being provided and the interface required for a fully functional and operational system upon project completion. Initial meetings shall be scheduled three months prior to the scheduled Substantial Completion date or as soon as Submittals are submitted and reviewed for projects with shorter schedules.
- B. Submit point designations for owner approval prior to entering in system.
- C. Partition Security system into up to 8 zones as designated by owner. Each zone shall have the capability of "All" Arm/disarm code or a separate Arm/disarm code.

3.13 CLEANING UP

- A. Upon completion of all work, and testing, thoroughly inspect all exposed portions of the installation and completely remove all exposed labels, markings, and foreign material.

3.14 PROJECT CLOSEOUT

- A. Provide close out submittals as required herein and in DIVISION 01 including the following close out submittals.
1. Operation and Maintenance Manuals
  2. Record Drawings.
  3. Test Reports.

3.15 SPARE PARTS/ATTIC STOCK:

- A. REQUIREMENTS:
1. Provide attic stock of the following quantities and parts for each piece of equipment as follows:

Equipment/Unit	Parts Description	Quantity
Security System	Card Printer Toner Cassettes	1
	Card Printer replacement drip unit	1
	Blank Credential Cards	500
	Motion detectors	5
	Card Readers	2
	10' Patch Cables	20
	6' Patch Cables	20
	3' Patch Cables	10
	2' Patch Cables	10
	Door Contacts	5

End of Section



Section 28 08 00

COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This section includes commissioning process requirements for communication systems, assemblies and equipment.
- B. Related Sections:
  - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "General Commissioning Requirements" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's role.
- B. Refer to Division 01 Section "Submittals" for specific requirements. In addition, provide the following:
- C. Certificates of readiness
- D. Certificates of completion of installation, prestart, and startup activities
- E. O&M manuals
- F. Test Reports.

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer' calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

**PART 2 - PRODUCTS**

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the contractor of Division 28 shall ultimately be responsible for all standard testing equipment for the electronic systems in Division 28. A sufficient quantity of two-way radios shall be provided by each contractor.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

### PART 3 - EXECUTION

#### 3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems
- B. **Red-lined Drawings:** The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. **Operation and Maintenance Data:** Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.
- D. **Demonstration and Training:** Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the Contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior the training session

#### 3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Perform tests as required by Division 28.
- B. Attend construction phase controls coordination meetings.
- C. Participate in Electronic systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CA.
- D. Provide information requested by the CxA for final commissioning documentation.
- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Electronic system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-up and task completion for owner. Distribute preliminary schedule to commissioning team members.
- G. Update schedule as required throughout the construction period.
- H. Assist the CxA in all verification and functional performance tests.

- 
- I. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
  - J. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
  - K. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
  - L. Notify the CxA a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.
  - M. Participate in, and schedule vendors and contractors to participate in the training sessions.
    - 1. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
    - 2. Security system.
  - N. The equipment supplier shall document the performance of his equipment.
  - O. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
  - P. Equipment Suppliers
    - 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
    - 2. Assist in equipment testing per agreements with contractors.
    - 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
  - Q. Refer to Division 01 Section "General Commissioning Requirements" for additional Contractor responsibilities.
- 3.3 CxA'S RESPONSIBILITIES
- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's Responsibilities.
- 3.4 TESTING PREPARATION
- A. Certify in writing to the CxA that Electronic systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
  - B. Certify in writing to the CxA that Electronic instrumentation and controls have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

- C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with building automation, smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.5 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Electronic testing shall include the entire Electronic system installation, from the incoming power equipment throughout to each peripheral and end device. Testing shall include measuring, but not limited to resistance, voltage, and amperage of system(s) and devices.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the Electronic system contractor and other contracted subcontractors, including the fire alarm Subcontractor shall prepare detailed testing plans, procedures, and checklists for Electronic systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Electronic system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

- 
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.
- 3.6 SECURITY SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES
- A. **Equipment Testing and Acceptance Procedures:** Testing requirements are specified in individual Division 28 sections. Provide submittals, test data, inspector record, infrared camera or special equipment and certifications to the CA.
- B. **Electronic Instrumentation and Control System Testing:** Field testing plans and testing requirements are specified in Division 28 Sections. Assist the CxA with preparation of testing plans.
- C. **Electronic System Testing (Access Control, CCTV and/or Security):** Provide technicians, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item to be tested.
- D. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:
1. Coordination and functionality with the Building Automation System/Building Management Controls System
  2. Security System
- 3.7 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT
- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.
- 3.8 APPROVAL
- A. Refer to Division 01 Section "General Commissioning Requirements" for approval procedures.
- 3.9 DEFERRED TESTING
- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deferred testing.
- 3.10 OPERATION AND MAINTENANCE MANUALS
- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.

- B. Refer to Division 01 Section "General Commissioning Requirements" for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.11 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to training.

End of Section

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SECTION 31 00 00  
EARTH MOVING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following
  - 1. Excavating, backfilling and compacting the Site as required to complete the Work shown on the Drawings and as specified herein, including selective excavation as required to expose and completely remove building foundations, slabs on grade, utilities, tunnels, and other site features and appurtenances.
  - 2. Preparing subgrades for landscaping.
  - 3. Removal of underground utilities as applicable.
  - 4. Subbase course for concrete pavements and equipment pads.
  - 5. Subbase and base course for asphalt paving.
  - 6. Excavating and backfilling for utility trenches and structures.
  - 7. Removal of items covered by Section 012200 - UNIT PRICES as applicable.
  - 8. Coordination and maintenance of safe path of travel for the public.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
  - 1. Section 312000 - EARTHWORK for soil materials, excavating, backfilling, and grading for the building, structures, slabs on grade, walls and foundations.
  - 2. Section 311000 - SITE CLEARING for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements.
  - 3. Section 312319 - DEWATERING for dewatering system for excavations.
  - 4. Section 312500 - EROSION AND SEDIMENTATION CONTROLS for temporary erosion and sedimentation control measures.
  - 5. Section 315000 - EXCAVATION SUPPORT AND PROTECTION for temporary excavation support and protection systems.
  - 6. Section 316317 - GROUND IMPROVEMENTS for foundation and earthwork support systems.

7. Division 02, 22, 23, and 26 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.

### 1.3 UNIT PRICES

- A. Unit prices for certain types of earthwork are included in Section 012200 - UNIT PRICES.
- B. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.

### 1.4 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
  1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
  2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
  1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Designer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
  2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
  3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Architect. Unauthorized excavation, as well as remedial work directed by the Architect, shall be without additional compensation.
- F. Fill: Soil materials used to raise existing grades.
- G. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating

equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables.

#### 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Each type of plastic warning tape.
  - 2. Geotextile.
  - 3. Controlled low-strength material, including design mixture.
  - 4. A detailed construction sequence plan for project excavation indicating temporary stockpile areas, side slopes of excavations, limits of any required temporary excavation support and sequence and procedures for slope protection, subgrade protection, excavation, concrete placement, moisture conditioning of on-site excavated soils used as fill, filling, backfill and compaction.
- B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
  - 1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
  - 2. Laboratory compaction curve according to ASTM D 1557 for each onsite and borrow soil material proposed for fill and backfill.
  - 3. Test reports for compliance with ASTM D2940 requirements for subbase material.
  - 4. Particle size Analysis in accordance with ASTM D422.
- C. Pre-excavation Photographs and Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins. Maintain catalog of up-to-date photographs at the site.
- D. Plan to Maintain Safe Path of Travel: Submit plans for maintaining safe paths of travel for the general public during the entire project, including requirement for police details of necessary.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the City of Framingham or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
  - 1. Notify the City of Framingham not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without the City of Framingham's written permission.
  - 3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

1.7 EXAMINATION OF SITE CONDITIONS AND DOCUMENTS

- A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation at the Site
- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period, as no allowance will be made for any errors or inaccuracies that may be found except as otherwise provided herein.

1.8 COORDINATION

- A. Prior to start of earthwork, the Contractor shall arrange an onsite meeting with the Architect, Engineer, the Geotechnical Engineer, and the testing agency for the purpose of establishing the Contractor's schedule of operations, and scheduling observation and testing procedures and requirements.
- B. As construction proceeds, the Contractor shall be responsible for notifying the Geotechnical Engineer and the testing agency prior to the start of earthwork operations requiring observation and/or testing.
- C. The work of this Section shall be coordinated with that of other trades affecting, or affected by, this work, as necessary to ensure the steady progress of all work of the Contract.

1.9 SUBSURFACE CONDITIONS

- A. Subsurface explorations have been performed at the site by the Geotechnical Engineer. The results of the explorations are included in the geotechnical report prepared by.

- B. The subsurface explorations and geotechnical report were performed primarily for use in preparing the foundation design. Use and interpretation of these data for purposes of the work shall be the responsibility of the Contractor. Subsurface conditions and groundwater levels are not considered as accurate for any times or locations other than the specific time and location of each of the explorations.
- C. Contractor may, at his own expense, conduct additional subsurface testing as required for his own information after approval by the Owner.
- D. The Contractor shall be responsible for determining the quantities of earth materials necessary to complete the work under this Section. All earth materials shall be included in the Contractor's base bid.
- E. Information on subsurface conditions is made available for the convenience of the Bidders. The Owner does not present the information to the Contractor as either an accurate or a comprehensive indication of subsurface conditions. Bidders are invited to review the information to apprise themselves of the information available, and also to make additional investigations at their own expense.
- F. No claim for extra cost or extension of time resulting from reliance by the Contractor on information presented herein shall be allowed, except as provided in the Contract Documents.

#### 1.10 PERMITS, CODES AND SAFETY REQUIREMENTS

- A. Work shall conform to the Contract Drawings and Specifications and shall comply with applicable codes and regulations. Present in writing to the Architect, all conflicts between the Contract Drawings, Specifications, and applicable codes and regulations, for resolution before commencing the Work.
- B. Comply with all rules, regulations, laws and ordinances of the City of Framingham and the Commonwealth of Massachusetts, and of all other authorities having jurisdiction. All labor, materials, equipment and services necessary to make the work comply with such requirements, shall be provided without additional cost to the Owner.
- C. The Contractor shall not close any street, sidewalk or passageway except as indicated on the Contract Drawings. The Contractor shall so conduct his operations as to interfere as little as possible with the use ordinarily made of roads, driveways, sidewalks or other facilities near enough to the work to be affected thereby.
- D. The Contractor shall procure and pay for all permits and licenses required for the complete work specified herein and shown on the Contract Drawings at no additional cost to the Owner. Arrange and pay for legal off-site disposal of all excess excavated materials, obtain proper disposal receipts from the applicable disposal facility for verification.
- E. Notify "Dig Safe" and the Owner before starting work; comply fully with utility company requirements.

#### 1.11 LAYOUT AND GRADES

- A. The Contractor shall maintain and/or re-establish benchmarks and survey monuments shown on the Contract Drawings or found to exist on the site to provide a base reference for the construction. Replace any that may become destroyed or disturbed. The Contractor shall employ and pay all costs for a registered Civil Engineer or Surveyor who is licensed within the jurisdiction of the project site to lay out all lines and grades in accordance with the Contract Drawings and Specifications, and as necessary or required for the construction.

#### 1.12 DISPOSITION OF EXISTING UTILITIES

- A. Active utilities existing on the site shall be carefully protected from damage and relocated or removed by others as specified in the Contract Documents. When an active utility line is exposed during construction, its location and elevation shall be plotted on the record Contract Drawings and both the Architect and Utility Owner notified in writing.
- B. Inactive or abandoned utilities encountered within the new building area during construction operations shall be removed. The location of such utilities shall be noted on the record Contract Drawings and reported in writing to the Architect.
- C. In removing existing abandoned utilities within the new building area, the Contractor shall also excavate all associated backfill material and replace with compacted Structural Fill.

#### 1.13 DISPOSAL

- A. The Contractor shall re-use on-site excavated soils on-site as Ordinary Fill as indicated below and in section 2.1. Solid waste consisting of brick, concrete, asphalt, cobbles and boulders that measure less than two cubic yards in volume shall become the property of the Contractor and be legally disposed of off-site at no additional cost to the Owner. Excavated on-site soils which are suitable for re-use at the time of excavation but become frozen or too wet for re-use due to poor material handling practices shall be disposed of off-site and replaced as necessary at no additional cost to the Owner.
- B. Solid waste resulting from screening or culling operations shall become the property of the Contractor and be legally disposed of off-site at no additional cost to the Owner.

#### 1.14 MEASUREMENT AND PAYMENT

- A. The base bid lump sum price shall include all costs of whatever nature associated with the content of this specification section and earthwork shown on the Contract Drawings including, but not limited to: demolition and removal of existing abandoned utilities and associated structures and appurtenances as indicated on the Contract Drawings, excavation for site improvements, removal of existing subsurface obstructions, segregating and all screening operations, stockpiling, handling and re-use of excavated materials, earthwork for paved areas, utilities, and site improvements,

construction dewatering, off-site disposal of all solid waste, placement and compaction of the specified fill materials in accordance with procedures documented herein, loading of all materials to be disposed of off-site and trucking and disposal of all Unregulated soil and solid waste.

- B. The Contractor shall include in his lump sum price all costs associated with excavating all existing fill, topsoil, subsoil and natural soil materials down to the surface of the design bearing strata consisting of the natural soil, followed by replacement with compacted fill as specified herein
- C. The Contractor shall include in his lump sum price all costs associated with segregating, culling and screening operations required for rendering the on-site fill material suitable for reuse on this project as Ordinary Fill material as defined herein.
- D. If any part of the excavation is carried through error beyond the depth directed by the Architect and the dimensions indicated on the Contract Drawings, or called for in the Specifications, the Contractor, at his own expense, shall furnish and install compacted Gravel Borrow, Crushed Stone or lean concrete as directed by the Architect up to the required level and/or dimensions.
- E. Compensation for all work required under this Section and not specifically covered elsewhere, shall be included in the Contract Lump Sum Price for Earthwork. For purposes of adjusting the scope of construction see the Unit Price Schedule.

#### 1.15 FIELD QUALITY CONTROL

- A. The Owner may retain and pay for the services of an independent testing agency to monitor backfill operations and to perform field density tests, and a Geotechnical Engineer to periodically observe the earthwork operations and observe the preparation of the subgrade for paved areas, equipment pads, and utility trenches and structures. The geotechnical engineer may from time to time request that the contractor excavate tests pits ahead of excavation to confirm subsurface conditions.
- B. The Contractor shall make provisions for allowing observations and testing of Contractor's Work by the Geotechnical Engineer and by the independent testing and inspection firm.
- C. Costs related to retesting due to unacceptable quality of work and failures discovered by testing shall be paid for by the Contractor at no additional expense to Owner, and the costs thereof will be deducted by the Owner from the Contract Sum.
- D. The Owner's Geotechnical Consultant's and/or Testing Agency's presence does not include supervision or direction of work by the Contractor, his/her employees or agents. Neither the presence of the Owner's Geotechnical Consultant and/or Testing Agency nor any observations performed by him/her, or any notice or failure to give notice, shall excuse the Contractor from deficiencies in the work.

**PART 2 - PRODUCTS**

2.1 SOIL MATERIALS

- A. General: Provide soil materials when sufficient satisfactory soil materials are not available from on-site excavations.
- B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
  - 2. Onsite material for use in compacted fill shall be natural inorganic granular soil taken from areas of cut after removal of pavement, topsoil, or other unsuitable materials. Onsite materials should be tested for compliance with the specifications before placement. Onsite materials with less than 40 percent fines and with maximum particle size of 6 inches or less can be reused. Onsite materials that do not meet the gradation requirements of the specification should be used in landscaped areas, relocated onsite if directed by the Owner, or disposed of offsite.
- D. Ordinary Fill shall consist of inert, hard, durable sand and gravel, free from ice and snow, organic matter, clay, surface coatings, and deleterious materials, and shall have a plasticity index of less than 6. Ordinary fill shall be placed in 12-inch loose lifts and shall conform to the following gradation requirements:

Sieve Size	Percent Passing By Weight
6-inches	100
1-inch	50-100
No. 4	20-100
No. 20	10-70
No. 60	5-45
No. 200	0-20

- E. Crushed Stone shall consist of durable crushed rock or durable crushed gravel stone, free from ice and snow, sand, clay, loam, or other deleterious material, conforming to SSHB, Section M2.01.0 through M2.01.6 size as indicated on Drawings. Crushed stone shall be uniformly blended and conform to the following gradation requirements.

<u>Sieve Size</u>	Percent Passing By Weight		
	<u>1/2-Inch Stone</u>	<u>3/4-Inch Stone</u>	<u>1.5-Inch Stone</u>
2 inches	100	100	100
1-1/2 inch	100	100	95-100
1 inch	100	100	35-70
3/4 inch	100	90-100	0-25



5/8 inch	100	---	---
1/2 inch	85-100	10-50	---
3/8 inch	15-45	0-20	---
No. 4	0-15	0-5	---
No. 8	0-5	---	---

- F. Subbase Material: Processed Gravel for subbase shall be naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand, meeting the requirements of SSHB Processed Gravel for Subbase, Section M1.03.1, Type B

<u>Sieve Size</u>	<u>Percent Passing By Weight</u>
3 inches	100
1-1/2 inches	70-100
3/4 inch	50-85
No. 4	30-60
No. 200	0-10

- G. Base Course: Dense Graded Crushed Stone for base course shall be naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand, consisting of angular material, that is hard, durable and free from clay, loam or other plastic material. Gradation shall conform to MHD Specification Designation, M2.01.7, and the following:

Sieve Size	Percent Passing By Weight
2 inches	100
1-1/2 inches	70-100
3/4 inch	50-85
No. 4	30-55
No. 50	8-24
No. 200	3-10

- H. Sand shall consist of clean inert, hard, durable grains of quartz or other hard durable rock, free from clay, organics, surface coatings or other deleterious material, confirming to SSHB Section M1.04.1. Sand shall conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
1/2-inch	100
3/8-inch	85-100
No. 4	60-100
No. 16	35-80
No. 50	10-55
No. 100	2-10

- I. Rip Rap shall be sound, durable rock which is angular in shape, confirming to SSHB, Section M2.02.3. Rounded stones, boulders, sandstone or similar stone or relatively thin slabs will not be acceptable. Each stone shall weigh not less than 50 pounds but not more than 125 pounds and at least 75 percent of the volume shall consist of stones weighing not less than 75 pounds each. The remainder of the stones shall be graded that when placed with the larger stones the entire mass will be compact.

## 2.2 GEOTEXTILES

- A. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
  2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
  3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
  4. Tear Strength: 90 lbf; ASTM D 4533.
  5. Puncture Strength: 90 lbf; ASTM D 4833.
  6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
  7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
  8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

## 2.3 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
1. Red: Electric.
  2. Yellow: Gas, oil, steam, and dangerous materials.
  3. Orange: Telephone and other communications.
  4. Blue: Water systems.
  5. Green: Sewer systems.

## 2.4 USE OF MATERIALS

- A. Use of materials shall be as described below and as shown in the Drawings.
- B. Ordinary Fill: Use Ordinary Fill as general site fill outside of the new building footprint area for embankments, landscaping, and beneath Processed Gravel for Subbase in paved areas where specified material such as Crushed Stone, Structural Fill, Crushed Stone and Sand are not indicated.
- C. Crushed Stone - Use crushed stone as indicated on the Drawings.
- D. Processed Gravel - Use for Subbase under paved areas.
- E. Dense Graded Crushed Stone - Use for base under paved areas.
- F. Sand – Use sand for bedding for utility bedding, setting bed for concrete block pavers, and as indicated elsewhere on the drawings

- G. Rip Rap – To be used at outlet pipes at flared end sections, emergency overflow at surface basin, and as indicated elsewhere on the drawings.
- H. Filter Fabric/Geotextiles- To be used as filter barriers at transition between soil and crushed stone, or other materials to assist in stabilizing soil subgrades, and as indicated elsewhere on the drawings. The edges of the fabric should be overlapped a minimum of one foot.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Section 311000 - SITE CLEARING.
- C. Protect and maintain erosion and sedimentation controls, which are specified in Section 311000 - SITE CLEARING, during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

#### **3.2 DEWATERING**

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area. Dispose of contaminated water in accordance with regulations of authorities having jurisdiction.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
  - 2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

#### **3.3 EXPLOSIVES**

- A. Explosives: Do not use explosives.

### 3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
  - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
    - a. 24 inches outside of concrete forms other than at footings.
    - b. 12 inches outside of concrete forms at footings.
    - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
    - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    - e. 6 inches beneath bottom of concrete slabs on grade.
    - f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

### 3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
  - 2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
  - 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

### 3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### 3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
  - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
  - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
  - 1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
  - 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
  - 3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

### 3.8 SUBGRADE INSPECTION

- A. Notify Designer when excavations have reached required subgrade.
- B. If Designer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
  - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
  - 2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
  - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Designer, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Designer, without additional compensation.

### 3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi may be used when approved by Designer.
  - 1. Fill unauthorized excavations under other construction or utility pipe as directed by Designer.

### 3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
  - 2. Stockpile soil materials in a location, acceptable to the City of Framingham Project Manager, that will preclude having to relocate stockpiled soil materials that would otherwise delay or impact the Work.

### 3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
  - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
  - 2. Surveying locations of underground utilities for Record Documents.
  - 3. Testing and inspecting underground utilities.
  - 4. Removing concrete formwork.
  - 5. Removing trash and debris.
  - 6. Removing temporary shoring and bracing, and sheeting.
  - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

### 3.12 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

- C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 - CAST-IN-PLACE CONCRETE.
- D. Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
- E. Place and compact initial backfill of subbase material free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
  - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- G. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### 3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
  - 1. Under grass and planted areas, use satisfactory soil material.
  - 2. Under walks and pavements, use satisfactory soil material.
  - 3. Under steps and ramps, use engineered fill.
  - 4. Under building slabs, use engineered fill.
  - 5. Under footings and foundations, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

### 3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

### 3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
  - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent; and areas within 10 feet of structures, building slabs, steps, and pavements at 92 percent.
  - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
  - 3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
  - 4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

### 3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - 1. Provide a smooth transition between adjacent existing grades and new grades.
  - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
  - 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
  - 2. Walks: Plus or minus 1 inch.
  - 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

### 3.17 SUB DRAINAGE

- A. Subdrain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of



filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 1557.

- B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 1557.
2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

### 3.18 SUBBASE AND BASE COURSES

- A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase and base course under pavements and walks as follows:
  1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
  2. Place base course material over subbase course under hot-mix asphalt pavement.
  3. Shape subbase and base course to required crown elevations and cross-slope grades.
  4. Place subbase and base course 6 inches or less in compacted thickness in a single layer.
  5. Place subbase and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  6. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
- C. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

### 3.19 DRAINAGE COURSE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

### 3.20 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Cooperate with the Independent Testing Agency engaged by the City of Framingham for field quality control activities for the Work of this Section. Refer also to Section 014325 - TESTING AGENCY SERVICES.
- B. Cooperate with field quality control personnel.
- C. Additional inspections and retesting of materials which fail to comply with specified material and installation requirements shall be performed at Contractor's expense.
- D. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- E. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Designer.
- F. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
  1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
  2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.
  3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.
- G. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.
- H. Notify the Independent Testing Agency a minimum of 72 hours prior to start of earthwork operations, to comply with Code requirement that a registered design professional be present at all times during backfill to assure adequate compaction with no bridging effects.

### 3.21 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
  - 1. Scarify or remove and replace soil material to depth as directed by Designer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

### 3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the User Agency's property.

END OF SECTION

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SECTION 31 10 00  
SITE CLEARING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
1. Protecting existing trees and vegetation to remain, including temporary fencing for trees in close proximity to construction operations.
  2. Removing existing trees and vegetation indicated to be removed.
  3. Clearing and grubbing.
  4. Stripping and stockpiling topsoil.
  5. Removing above and below grade site improvements.
  6. Disconnecting, capping or sealing of utilities as required.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. Section 312000 – EARTH WORK for soil materials, excavating, backfilling, and grading for the building, structures, slabs on grade, walls and foundations.
  2. Section 310000 - EARTH MOVING for soil materials, excavating, backfilling, and site grading and removal of site utilities.
  3. Section 312500 - EROSION AND SEDIMENTATION CONTROLS for required erosion and sedimentation control measures.

1.3 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

- B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

#### 1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain the City of Framingham's property, cleared materials shall become Contractor's property and shall be removed from Project site.

#### 1.5 SUBMITTALS

- A. Photographs sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record drawings, according to Section 017700 - CONTRACT CLOSEOUT identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

#### 1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Project Manager and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvagable Improvements: Carefully remove items indicated to be salvaged and store on User Agency's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until erosion and sedimentation control measures are in place.
- E. Protection of Existing Improvements: Provide protection necessary to prevent damage to existing improvements indicated to remain in place or outside of the limit of work. Protect improvements on adjoining properties and on User Agency's property.
  - 1. Restore improvements damaged by Contractor's clearing activities to their original condition, at no additional expense to the City of Framingham.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to the Architect.

3.2 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
  - 1. Do not store construction materials, debris, or excavated material within fenced area.
  - 2. Do not permit vehicles, equipment, or foot traffic within fenced area.
  - 3. Maintain fenced area free of weeds and trash.
  - 4. Except as otherwise directed, cutting and trimming of existing trees will not be permitted.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
  - 1. Cover exposed roots with burlap and water regularly.
  - 2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
  - 3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
  - 4. Backfill with soil as soon as possible.

- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by the Architect.
  - 1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
  - 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the Architect.

### 3.3 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
  - 1. Arrange with utility companies to shut off indicated utilities.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the City of Framingham Project Manager or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify the Architect not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without the City of Framingham's written permission.
- C. Removal of underground utilities is included in Section 310000 – EARTH MOVING.
- D. Removal of underground utilities is included in Division 2 Sections covering site utilities.

### 3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
  - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
  - 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
  - 4. Use only hand methods for grubbing within tree protection zone.
  - 5. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.



### 3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - 1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust or contamination by air-borne weed seed.
  - 1. Limit height of topsoil stockpiles to 72 inches.
  - 2. Do not stockpile topsoil within tree protection zones.

### 3.6 EXCESS TOPSOIL

- A. Topsoil that has been stripped and stockpiled, but is not needed after the completion of all final topsoil spreading and grassing, shall be stockpiled on site in a location to be approved by the User Agency and shall remain the property of the City of Framingham.

### 3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
  - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
  - 2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

### 3.8 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off the City of Framingham's property.
  - 1. Burning on site is prohibited.
  - 2. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION

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SECTION 31 20 00

EARTHWORK

**PART 1 GENERAL**

1.1. GENERAL

- A. Drawings and General Provisions of the Contract apply to this Section.
- B. Examine all drawings and all other Sections of the Specifications for requirements therein affecting the work of this and related Sections.
- C. Coordinate work with that of all other trades affecting or affected by the work of this and related sections. Cooperation with such trades to assure the steady progress of all work under the Contract

1.2. DESCRIPTION OF WORK

- A. Work to be done under this Section includes, but is not limited to, providing all labor, materials, equipment, and incidentals as necessary to conduct and complete the work specified herein and shown on the Drawings.
  - 1. Pre-excavate along the alignments of the temporary excavation support system to bottom of previous foundation to remove obstructions and loose sands.
  - 2. Excavate all materials, including soil, boulders, abandoned utilities, abandoned building foundations, construction debris, pavements, curbs, concrete slab, granite blocks, and all other materials as necessary to construct the improvements shown on the Drawings.
  - 3. Preserve and protect existing and new site improvements and adjacent site improvements during the course of the Work.
  - 4. Prepare, grade, shape, compact, and protect all subgrades, backfills, and ground surfaces for building, structures, and landscaping as shown on the Drawings.
  - 5. Perform earthwork associated with Rammed Aggregate Pier (RAP) and/or Rigid Inclusion (RI) ground improvement design including but not limited to removal of obstructions, spoil removal, footing excavations, slab excavation, and footing/slab subgrade preparation, including but not limited to construction of load transfer platform and footing and slab pads, following RAP/RI installation.
  - 6. Furnish materials from off-site source acceptable to Owner as required to complete the Work.
  - 7. Control dust to specified level. No soil shall leave or be imported to the site without Owner's approval.
  - 8. Place and compact backfill materials to construct the improvements shown on the Drawings.
  - 9. Placement, settlement monitoring, and removal of surcharge as shown on drawings.
  - 10. Subbase course for bituminous and cement concrete pavements.
  - 11. Subsurface drainage backfill for walls and trenches.
  - 12. Excavating, backfilling, and compacting for utility trenches
  - 13. Placement of Ordinary Borrow for fill and embankment areas.
  - 14. Placement gravel for base courses.

15. Crushed stone shall be installed in areas shown on the plans or as directed by the Engineer.
16. Segregate, handle, stockpile, manage, and reuse suitable excavated materials as specified in Contract Documents.
17. Contractor is responsible for the legal disposal, reuse, or recycling of all soil, excavated materials, and groundwater at locations acceptable to the Owner and in conformance with all federal, state, and local regulations.
18. Design, install, and maintain a temporary excavation support system for construction of the below-grade-space and other site improvements, as necessary, in accordance with the criteria herein and related Sections.
19. Coordination with maintenance of safe path of travel for the public.
20. Design, provide, install, operate, maintain, and remove temporary dewatering system to remove groundwater, perched groundwater, groundwater seepage, precipitation, and surface water runoff from excavations in accordance with required specified herein.
21. No soil or processed fill shall be brought onto the site without prior approval from the Owner's Representative.
22. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.
23. All work shall be conducted to meet project vibration criteria, settlement limits, and Town of Framingham and Fuller Middle School Project noise and dust criteria.
24. Removal of items covered by Section 012200 - UNIT PRICES as applicable.
- 25.

1.3. RELATED WORK SPECIFIED ELSEWHERE

- A. Section 31 00 00 - Earth Moving
- B. Section 31 23 19 - Dewatering
- C. Section 31 63 17 - Aggregate Pier and Rigid Inclusion Ground Improvement
- D. Division 02, 22, 23, and 26 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.

1.4. DEFINITIONS

- A. Owner: Town of Framingham, Massachusetts, Fuller Middle School
- B. Architect: Jonathan Levi Architects
- C. Engineer: Authorized representatives of the Architect or Owner
- D. Owner's Representative: Authorize representatives of the Owner.
- E. Site Improvement: When used in the context of "protecting adjacent site improvements" shall include, but not be limited to, buildings, utilities, pavements, roadways, slabs, sidewalks, curbs, foundations, slopes, and all other improvements and features that are outside the limits of the site, or those elements within the limits of the site that are to remain.
- F. Zone of Influence (ZOI): The zone containing the bearing soils for soil-supported structures. The ZOI is defined by imaginary lines extending 3 feet laterally from the outside lower edges of the soil bearing structures and down a 1 horizontal to 1 vertical slope to the top of the natural, inorganic bearing soils or other approved bearing soils.
- G. Unsuitable Material: Unsuitable material shall be material determined by the Engineer to be unsuitable in its natural location and condition as a foundation

material, as a sub-base, or as a part of the finished site work. Unsuitable material may include, but not limited to, clays, silts, very wet material, very plastic material, peat, muck, logs, stumps, roots, grass, sod, highly organic material, refuse, ashes, and other types of unsuitable material.

- H. Satisfactory Soils: ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM or a combination of these groups; free of rock or gravel larger than 4 inches in any dimensions, debris, waste, frozen materials, vegetation, and other deleterious matter.
- I. ASTM: American Society for the Testing and Materials.
- J. AASHTO: American Association of State Highway and Transportation Officials
- K. ACI: American Concrete Institute
- L. AWS: American Welding Society (Standard Code for Welding in Building Construction)
- M. Code: International Building Code 1009 with Massachusetts Amendments (Eighth Edition)
- N. OSHA: Occupational Health and Safety Administration

#### 1.5. REFERENCED STANDARDS

- A. ASTM D 2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- B. ASTM D 1556-07, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
- C. ASTM D 1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
- D. ASTM D 3017, Standard Method for Water Content for Soil and Rock in Place by Nuclear Methods (Shallow Depth)
- E. ASTM D 422 – 63 (2007), Standard Test Method for Particle-Size Analysis of Soils
- F. ASTM D6938-08a, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- G. ASTM D4318-05, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

#### 1.6. PROJECT CONDITIONS

- A. Refer to project Geotechnical Data and Engineering Report by RSE Associates (3 May 2019) for description of subsurface conditions encountered at boring locations. Note that the opinions expressed in this report are those of geotechnical engineer based on interpretations of subsurface conditions and tests on soil samples obtained from selected locations and depths. The existing subsurface data may not be sufficient to address all construction needs and the Contractor can make additional test borings as well as field and laboratory tests as necessary at no additional cost to the owner to fulfill Contractors' needs such as for the design of temporary support-of-excavation system.
- B. Excavation to construct the proposed improvements will primarily be fill, organics, glacial lacustrine, and glacial outwash. Miscellaneous debris including but not limited to abandoned pipes, bricks, building materials ... etc., may be present in the zone of excavation and below proposed slab and foundation.
- C. Limit all vibrations to 0.5 inch per second or less at and in all buildings. The Contractor shall maintain the maximum cumulative horizontal movement at any point along the temporary excavation support wall, if used, to less than the limiting value of 1/4-in. Limit settlements of all adjacent structures, utilities, and other improvements to 1/4" or less.
- D. Conduct all work within project and City noise and dust limits.

- E. Existing Utilities: Do not interrupt utilities serving facilities occupied by others unless permitted in writing by the Owner and then only after arranging to provide temporary utility services according to Owner's requirements.
- F. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if liens are active.
- G. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, slope, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
- H. Notify the Engineer in writing if unexpected subsurface conditions are encountered.

#### 1.7. QUALITY CONTROL

- A. The Owner's Representative will observe the Contractor's earthwork activities, including temporary excavation support system installation, excavation, dewatering, subgrade preparation, and backfilling. The Contractor shall provide sufficient notice to Owner's Representative to allow the Owner's Representative to be present to observe and test the Work. The Owner's Representative shall make such tests of materials and samples as necessary to insure material and compaction requirements are achieved.
- B. No soil shall be brought onto the site or removed from the site without approval by the Engineer.
- C. The Owner's Representative shall be notified before each placement of backfill onsite.
- D. The Owner's Representative will conduct field and laboratory testing to confirm compliance with the requirements of this Section. Field and laboratory testing will be conducted in general conformance with ASTM or other applicable reference standards. The Owner's Representative may also conduct vibration monitoring as necessary. The Contractor shall cooperate with the Owner's Representative in all respects to facilitate any testing or observations.
- E. The presence of the Owner's Representative shall not relieve the Contractor of its responsibility to perform the Work in accordance with the Contract Documents, nor shall it be construed to relieve the Contractor from full responsibility for the means and methods of construction, protection of site improvements against damage, and for safety on the construction site.
- F. The Contractor shall adhere to the applicable requirements of the Standard Specifications, OSHA Standards, and to all other applicable ordinances, codes, statutory rules, and regulations of federal, state, and local authorities having jurisdiction over the Work of this Section and other applicable Sections.
- G. The Contractor may conduct additional geotechnical field and laboratory testing or screening for its own information at no additional cost to the Owner.
- H. Work not in conformance with the specified requirements shall be improved, or removed and replaced, at no additional cost to the Owner. All costs related to testing of nonconforming Work or materials shall be paid for by the Contractor at no additional cost to the Owner.
- I. Tolerances
  - 1. Construct finished soil and backfill surfaces to +/- 1/2 in. of the grades and elevations indicated on the Drawings.

2. Maintain the moisture content of fill material as it is being placed to levels that allow for compaction to the specified degree of compaction.

1.8. SUBMITTALS

- A. General
  1. The Contractor shall forward submittals to the Architect a minimum of 2 weeks prior to any planned work related to the Contractor's submittals.
  2. The time period(s) for submittals are the minimum required by the Architect to review, comment, and respond to the Contractor. The Architect may require resubmission(s) for various reasons. The Contractor is responsible for scheduling specified submittals and resubmittals so as to prevent delays in the work.
  3. The Contractor's submittals shall be reviewed and accepted by the Architect prior to conducting any work.
  4. The Contractor's submittals shall be prepared and stamped by a Professional Engineer registered in the Commonwealth of Massachusetts, retained by the Contractor (unless otherwise approved by the Architect).
  5. Acceptance of the Contractor's submittals by the Architect does not relieve the Contractor of the responsibility for the adequacy, safety, and performance of the Work.
- B. Pre-excavation Photographs and Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins. Maintain catalog of up-to-date photographs at the site.
- C. Plan to Maintain Safe Path of Travel: Submit plans for maintaining safe paths of travel for the general public during the entire project, including requirement for police details of necessary.
- D. Pre-excavation
  1. Methods for pre-excavation along the alignments of the temporary excavation support systems including procedures for obstruction removal, excavation support, protection of site improvements, backfilling, and specific methods to support utilities within close proximity.
- E. Mass Excavation
  1. A narrative and drawings (plans and elevations) describing the schedule, sequence, and procedures for pre-excavation, temporary excavation support system installation, excavation, subgrade preparation, foundation construction, cold weather subgrade protection, backfilling, dewatering, soil handling, stockpiling, and other related activities.
  2. Shop drawings and calculations of the proposed temporary excavation support system(s) signed and sealed by a qualified professional engineer showing details, location layout, elevations, allowable temporary traffic surcharge in the vicinity of the proposed excavation, and methods of sequence of installation, construction, and removal. The temporary support-of-excavation system shall not interfere with permanent structures and foundations.
  3. Qualification of the installer and professional engineer currently registered in the Commonwealth of Massachusetts.
  4. Dewatering design and layout during mass excavation.
  5. Provide survey locations and description of any excavation support systems left in place.
- F. Backfill Materials and Equipment

1. Proposed type and source of all fill and backfill materials. For each type of soil to be utilized as fill or backfill, the Contractor shall provide the following documentation:
  - a. Two 50-lb bag samples of the proposed fill.
  - b. Location of borrow source site, including name of the owner or facility name (from which the backfill originates) with contact phone number, email, street address, city, and state.
  - c. Present and past usage of the source site and material.
  - d. Volume of soil originating from each source area.
  - e. Name of the qualified firm and analytical laboratory that performed the material sampling and testing.
  - f. All existing report(s) associated with an assessment of the source site as relates to the presence of oil or hazardous materials.
2. The Contractor shall provide a grain size analysis, in accordance with ASTM D422 or ASTM D6913, and laboratory compaction curve, in accordance with ASTM D1557, for each onsite and borrow material proposed for backfill. Contractor shall provide additional grain size and compaction tests for every 200 cubic yards of the same material delivered to the site.
3. The Contractor shall, prior to the delivery of any incoming backfill material to be used at the project site, provide the contract information for the facility in which the backfill originates and the results of analytical testing of representative samples of the material for review and acceptance. The Contractor shall demonstrate that the incoming backfill material is naturally deposited soil and the analyte concentrations of the off-site backfill do not exceed the Reportable Concentrations RCS-1 of the MCP.
  - a. The Contractor shall provide soil analyses for the following parameters: 8 RCRA metals; TCLP for any RCRA metal with total concentration in excess of the "20X rule", Extractable and Volatile Petroleum Hydrocarbons (EPH/VPH) by Mass DEP methodologies; Volatile and Semi-Volatile Organic Compounds (by EPA Method 8260B with Method 5035 and EPA Method 8270, respectively), herbicides/pesticides and PCBs. The soil shall not contain any visual evidence of asbestos containing materials (ACMs).
  - b. Urban backfill will not be accepted from off-site sources.
  - c. No backfill will be accepted from off-site sources that are now or were formerly listed as sites regulated under the MCP.
  - d. Test results must be submitted a minimum of four weeks prior to use of borrow to provide for data review by Owner.
  - e. The Contractor shall provide an LSP opinion indicating the backfill material meets the criteria established above.
4. Details of compaction equipment, including descriptions, product literature, specifications and ratings, proposed for use in compacting fill and backfill materials.

## **PART 2 PRODUCTS**

### **2.1 SOIL MATERIALS**

- A. All material to be imported to the site shall not contain concentrations of metals above naturally-occurring background levels as defined by the Department of Environmental Protection. All materials to be imported to the site shall not contain detectable amounts of all other oil and/or hazardous materials as defined by the Massachusetts Contingency Plan (CMR 40.0000).



- B. Structural Fill: shall consist of granular inert material that is hard, durable stone and coarse sand, free of excess moisture, frozen lumps, roots, sod, trash, metal, plastic, clay, and other deleterious materials and conforming to the following specifications:

Maximum particle size	3 inches
Sieve ½" (12.5 mm)	50 – 85% passing
Sieve #4 (4.75 mm)	40 to 75% passing
Sieve #50 (300 □m)	8 – 28% passing
Passing #200 sieve (75 □m)	5% max.

Structural Fill shall be used below footings, sidewalks, slab-on grade, and at other locations shown on the Drawings or indicated in the Specifications. Structural Fill shall also be used to backfill above, below, and to the sides of new site structures and utilities and below pavements unless otherwise noted on the Drawings or approved by the Architect.

- C. ¾-in Crushed Stone: shall conform to the requirement of item M2.01.4 of the MHD Standard Specifications for Highways and Bridges, dated 1988. Crushed Stone (¾-in.) shall be washed at the source facility to remove fine-grained soils.
- D. 1½-in Crushed Stone: shall conform to the requirements of item M2.01.4 of the MHD Standard Specifications for Highways and Bridges, dated 1988. Crushed stone (1-1/2-in.) shall be washed at the source facility to remove fine-grained soils.
- E. Lean Concrete: shall have a maximum 28-day compressive strength of  $f'c = 1,500$  psi, unless otherwise noted, with a maximum slump of 6 in. Lean concrete may be used to backfill excavations in lieu of Structural fill at locations proposed by the Contractor and approved by the Owner's Representative.
- F. Gravel Borrow, Type C: Gravel Borrow, Type C, shall be used as pipe bedding, unless shown or directed otherwise by the Engineer, with the exception of Fiber Reinforced Pipe, place between 6 inches below pipe invert to 6 inches above pipe crown and shall meet the material requirements of Mass DOT Standard Specifications section M 1.03.0.
- G. Process Gravel for Subbase: Shall be in accordance with Mass DOT Standard Specifications section M 1.03.1.
- H. Sand Borrow: Sand Borrow shall be in accordance with Mass DOT Standard Specifications section M1.04.0.
- I. Sand Borrow for Subdrains: Shall be in accordance with Mass DOT Standard Specifications section M1.04.1.

## 2.2 GEOTEXTILE AND GEOGRID

- A. Geotextile shall be of type and properties required for specific application as determined by the Engineer.
- Geogrid used for subgrade reinforcement shall be TenCate Mirafi BXG 120 or similar.
  - Geotextile used for marker barrier and provide separation around ¾ crushed stones placed around pipes shall be constructed of a non-woven high visibility geotextile, TenCate Mirafi Orange Delineation 140N or approved equal.
  - Geotextile used for separation shall be non-woven TenCate Mirafi 140N or approved equal.
  - Geotextile used below concrete sidewalk within the Amphitheater shall be TenCate Mirafi HP270 or equal.
  - Geotextile used below bituminous concrete pavement within Amphitheater shall be TenCate Mirafi HP 570 or equal.

## PART 3 EXECUTION

### 3.1 INSPECTION

- A. Examine the site and report to the Architect in writing any conditions detrimental to the proper and timely completion of the Work of this Section. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.
- B. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.
- C. Preconstruction survey of the Mass Bay Community College shall be performed documenting existing building conditions using combination of written observations, measurements, and photographs prior to commencement of construction activities at the site.
- D. Preconstruction survey, consisting of written observations, measurements, and photographs prior to commencement of construction activities shall be performed for 85, 91, 99, 103, 105, 107, 109, and 111 Oaks Road, and 34 and 37 Fraser Road in Framingham, Massachusetts.
- E. Preconstruction survey, consisting of written observations, measurements, and photographs prior to commencement of construction activities shall be performed for the existing Fuller Middle School in Framingham, Massachusetts.

### 3.2 DUST CONTROL

- A. The Contractor shall employ dust control measures to minimize the creation of airborne dust during the entire construction process. As a minimum, standard dust control techniques shall be employed where heavy equipment will be traveling such as watering-down the site and routine street sweeping. The Contractor shall not utilize dust control measures that change the chemical characterization of site soils.
- B. The acceptable limit for total airborne dust will be based on the National Primary Ambient Air Quality Standard as promulgated by the U.S. Environmental Protection Agency and as referenced by the Massachusetts Department of Environmental Protection. In brief, this standard establishes a maximum 24-hour permissible concentration of 150 micrograms per cubic meter and a real time 2-hr average of 200 micrograms per cubic meter. The Contractor shall immediately take measures to control dust if the limits are exceeded. The Contractor shall take all necessary steps to reduce and maintain dust levels below these levels.
- C. In addition to all other standards and requirements, the Contractor shall take all measures to prevent visible airborne dust from leaving the site.

### 3.3 DEWATERING

- A. The Contractor shall provide, at his own expense, adequate pumping and drainage facilities to maintain the excavated area sufficiently dry from groundwater and/or surface runoff so as not to adversely affect construction procedures nor cause excessive disturbance of underlying natural ground. The flow of all water resulting from pumping shall be managed so as not to cause erosion, siltation of drainage systems, or damage to adjacent property. The water from pumping shall be properly disposed of in accordance to federal, state, and local regulations
- B. The Contractor shall control the grading in the area surrounding all excavations so that the surface of the ground will be properly sloped to prevent water from running into the excavation area. Where required, temporary ditches shall be provided to

control drainage. Upon completion of the work and when directed, all areas shall be restored by the Contractor in a satisfactory manner and as directed.

- C. Any damage resulting from the failure of the dewatering operations of the Contractor, and any damage resulting from the failure of the Contractor to maintain all the area of work in suitable dry condition, shall be repaired by the Contractor, as directed by the Owner's Representative, at no additional expense to the Owner. The Contractor's pumping and dewatering operations shall be carried out in such a manner as to prevent damage to the Contract work and so that no loss of ground will result from these operations. Precautions shall be taken to protect new work from flooding during storms or from other causes. Pumping shall be continuous to protect the work and/or to maintain satisfactory progress.

### 3.4 GENERAL REQUIREMENTS

- A. The Contractor shall conduct all work associated with excavation to maintain vibrations below limiting values listed in Contract Documents. Minimum of two vibration monitoring points are required at all time.
- B. The Contractor shall expect to encounter remnants of utilities, foundations, granite blocks, masonry, concrete slabs, and other buried structures during pre-trenching, general excavation, and installation of temporary excavation support systems.
- C. Excavation, backfilling, and other earthwork activities shall conform with the Contract Documents and submittals that are acceptable to the Architect. No work shall be performed unless it is conducted under the observation of the Architect, and in accordance with the submitted schedule and sequence.
- D. Prevent erosion at the site at all times. The Contractor shall install all measures needed to control sediment and erosion as required by the Contractor operations, the weather conditions, and as directed by the Owner's Representative.
- E. All excavated material shall be removed from the site and shall be legally disposed of by the Contractor in accordance with Project Specifications.
- F. The Contractor can reuse excavated on-site soils as backfill at this site provided that the material meets the backfill requirement.
- G. The Contractor shall not excavate or remove any material from within the site or right of way which is not within the excavation, as indicated, without written authorization from the Owner.
- H. If unanticipated contaminated material is suspected or encountered during an excavation, the Contractor shall contact the Architect as soon as possible. The Architect will provide direction on how to proceed and disposition of the excavated material.
- I. Unfavorable Weather
  - 1. Freezing Weather
    - a. Fill materials and/or concrete shall not be frozen and not placed on snow, ice, frozen subgrade, or uncompacted frozen soil.
    - b. Fill material and lean concrete shall not be frozen when placed or be allowed to freeze prior to or after compaction or placement. At the end of each day's work during freezing weather, the last lift of fill, after compaction, shall be rolled by a smooth-wheeled roller to eliminate ridges of uncompacted soil. Fill materials and lean concrete shall be covered with insulating tarps or heated during freezing weather. The Contractor shall suspend backfilling operations and placement of lean concrete and any fill when air temperatures are below 32 degrees F.
    - c. Soil bearing surfaces below completed slabs and foundations shall be protected against freezing, before and after concreting. Frost protection

- shall be provided as soon as possible after foundations or structures are constructed in a manner acceptable to the Owner's Representative.
- d. Do not excavate to final invert when freezing temperatures may be expected, unless the mat, footing, or slab is poured immediately after the excavation has been completed. Protect the excavation from frost if placing of concrete is delayed. Where footings, slabs or mudmats are exposed to freezing temperatures, they shall be protected to prevent damage to the concrete by freezing or frost penetration into the soil upon which they rest. Where foundations are exposed over the winter during construction, provide at least the equivalent of 4 ft of earth cover above the bottom surface of concrete.
2. Wet Weather
- a. If fill material placement, spreading, rolling, or compaction operations are interrupted by rain or other unfavorable conditions, do not resume such operations until ascertaining that the moisture content and density of the previous placed soil are as required by these specifications.
- J. The Contactor shall be responsible for the stability of excavation and overall onsite job safety. Shoring, trenching, and other excavation activities shall be in accordance with the latest requirements of the Department of Labor Occupational Health and Safety. The Contractor shall coordinate excavation activities to maintain vertical movements of the adjacent buildings and lateral movements below the Limiting Values.

### 3.5 PRETRENCHING/PRE-EXCAVATION

- A. Pretrench along the alignments of the temporary excavation support systems to remove existing below grade structures. The Contractor shall propose methods for excavation and obstruction removal that are acceptable to the Owner's Representative. The pre-excitation shall extend from the ground surface to the bottom of the fill.
- B. Backfill pretrench excavations with approved material that is suitable for re-excitation with nominal effort for future construction or to remain as the permanent backfill. No pretrench excavations shall be left open overnight.

### 3.6 EXCAVATION

- A. The Contractor shall be responsible for the stability of excavation and overall onsite job safety. Shoring, trenching, and other excavation activities shall be in accordance with the latest requirements of the Department of Labor Occupational Health and Safety. The Contractor shall coordinate excavation activities to maintain vertical movements, lateral movements, and construction-induced vibrations below the Limiting Values.
- B. Excavate to the lines and grades indicated, and no deeper unless approved. Conduct excavation in such a manner that movements of temporary excavation support systems, if present, are minimized and damage to adjacent buildings, structures and utilities is prevented. Prevent disturbance to soil subgrades and exercise care to preserve the material below and beyond the lines of all excavations.
- C. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- D. The use of tiebacks is not permitted on this Project.

- E. When excavation has reached required subgrade elevations, notify the Owner's Representative, who will observe the excavation and bearing conditions. After review by the Owner's Representative, the excavation may be required to proceed deeper due to variation in subgrade conditions, presence of unsuitable soils at the design subgrade level, or Contractor disturbance of the subgrade. The Contractor shall overexcavate and replaced the excavated material with compacted Structural fill or Lean Concrete as directed by the Owner's Representative at no additional cost to the Owner.
- F. Excavate trenches to the depth indicated or required. Carry the depth of trenches for piping to establish the indicated flow lines and invert elevations. Excavation for the convenience of the Contractor shall conform to limits acceptable to the Architect, and shall be at no additional cost to the Owner.
- G. Unauthorized excavation consists of removal of materials beyond required subgrade elevations or dimensions without specific direction of the Architect. Backfill and compact unauthorized excavations with Structural Fill or Lean Concrete as specified for unauthorized excavation unless otherwise directed by the Owner's Representative. Unauthorized excavation, as well as remedial work directed by the Architect, shall be at the Contractor's expense.
- H. Bottom of all excavations shall be properly proof-rolled, leveled and trimmed to the lines and grades required for Work. The final excavation for all footing and slab subgrades shall be performed with excavating equipment with a smooth-edged excavating bucket.
- I. No excavation will be permitted below a line drawn downwards at a slope of 2 horizontal to 1 vertical from the underside of the closest edge of any proposed or in-place footing or utility at a higher elevation without providing adequate sheeting, bracing and/or underpinning to prevent loss of support of footing or utility.
- J. Remove temporary excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection system.

### 3.7 SUBGRADE PREPARATION AND PROTECTION

- A. General
  - 1. Complete the excavation to the required subgrade elevation or bearing material.
  - 2. All subgrades must be accepted by the Owner's Representative prior to placement of Structural Fill, Lean Concrete, or any structure over the subgrade.
- B. The final excavation for all footing subgrades shall be at specified elevation bearing on load transfer platform specified by the RAP/RI Designer. The surface shall be proof-rolled, remain undisturbed and protected from disturbance prior to and during footing construction.

### 3.8 BACKFILLING

- A. General
  - 1. Backfilling activities, including placement and compaction, shall not be performed when air temperatures are at or below 32 degrees F.

2. Backfill excavation as promptly as work permits, but not until the subgrade, or below grade construction, is acceptable to the Owner's Representative
3. Previously placed, and possibly accepted, backfill shall be excavated and replaced at no additional cost if the backfill does not conform to the Contract Documents.
4. During compaction operations, incidental compaction due to traffic by construction equipment other than that used specifically in compaction operation will not be credited toward the required minimum coverages specified.
5. Compaction by puddling or flooding is prohibited.
6. Exercise care in placement of backfill against walls and directly in contact with waterproofed structures such that stones contained in the backfill do not damage waterproofing.
7. Repair any damage to waterproofing that occurs during placement and compaction operations at no additional cost to the Owner.
8. Control groundwater as required to permit efficient collection and removal with minimal disturbance to materials being placed.
9. Placement of fill and backfill shall be systematically conducted in the specified uniform layer thickness.
10. Backfill excavations as promptly as work permits but not until acceptance by the Owner's Representative and completion of quality control testing.
11. During utility trench backfill, place and compact bedding course on trench bottom and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipe and for joints, fittings, and bodies of conduits. Bedding shall be placed, in layers not more than 6 inches thick in loose depth, and each layer shall be thoroughly and evenly compacted by tamping on each side of the pipe to provide uniform support around the pipe, free from voids. Crushed stone bedding material shall be placed in layers not more than 6-inches thick in loose measure, and compacted with at least 4 passes using a vibratory plate or roller compactor.

B. Backfill Materials

1. Backfill materials brought to the site must be obtained from an approved borrow source(s).
2. Backfill material below footings shall meet specifications of load transfer platform by the RAP/RI Designer.
3. Under grass and planted areas and below topsoil, use satisfactory soil material.
4. Under walks and pavements, use structural fill.
5. Under slabs, use required subgrade material specified by the RAP/RI Designer.
6. Under steps and ramps, use structural fill.
7. Behind retaining wall, use structural fill.

C. Compaction Equipment

1. In all cases, the Contractor shall only use compaction equipment that is deemed acceptable by the Owner's Representative or RAP/RI Designer for areas above ground improvement.
2. Compact with a minimum of four passes/coverages of acceptable compaction equipment.
3. Compaction in confined areas (against walls, piers, and in trenches) shall be conducted with acceptable equipment such as hand-guided vibratory

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compactors or mechanical tampers as approved by the Owner's Representative.

D. Placement, Compaction, and Protection

1. All backfill material shall be placed "in-the-dry" on subgrades acceptable to the Owner's Representative. The Contractor shall dewater excavated areas as required to perform the work in such a manner as to preserve the undisturbed state of the approved subgrade material.
2. Backfill materials shall not be placed on snow, ice, frozen subgrade, or uncompacted frozen soil.
3. Backfill material shall not be frozen when placed or be allowed to freeze prior to or after compaction, placement, or curing. At the end of each day's work during freezing weather, the last lift of fill, after compaction, shall be followed by smooth-wheeled roller to eliminate ridges of uncompacted soil.
4. In-place density tests shall be made in accordance with ASTM D1556, D6938 or D2167 as the work progresses, to determine the degree of compaction being attained by the contractor. Any corrective work required as a result of such tests, such as additional compaction, or a decrease in the thickness of layers, shall be performed by the Contractor at no additional expense to the Owner. In-place density testing shall be made at the Contractor's expense by the geotechnical testing laboratory.
5. In-place density tests shall be performed at a minimum one per footing if subgrade consists of structural fill. For footing subgrade consisting of  $\frac{3}{4}$ " crushed stones, testing requirement shall conform to specifications defined by RAP/RI Designer.
6. The degree of compaction is expressed as a percentage of the maximum dry density of the material at optimum moisture content as determined by ASTM Test D1557, Method C. The compaction requirement for Structural fill is 95% of the maximum dry density. Compaction requirement for satisfactory fill material is 95%.
7. Structural fill shall be placed and compacted in lift thickness not exceeding 8 inches.
8. Any trenches or excavations improperly backfilled or where settlement occurs shall be reopened, to the depth required for proper compaction then refilled and compacted with the surface restored to the required grade and condition, at no additional expense to the Owner.

E. Subsurface Drainage

1. Subdrainage Pipe: Specified in Division 2 Section "Subdrainage"
2. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in minimum of 12 inches of filter material, placed in compacted layers of 6 inches thick, and wrap in surface drainage geotextile, overlapping sides and ends at least 6 inches. Compact each filter material layer to 85% of maximum dry unit weight in accordance to ASTM D1557.

**PART 4 MEASUREMENT AND PAYMENT**

4.1 GENERAL

- A. All work in this Section will be paid as part of the Base Contract Price and shall include furnishing all material, mobilization, labor, equipment, tools, and incidentals

necessary to complete the work shown on the Drawings and specified in the Contract Documents. No separate measurement or payment will be made for acquisition of permit, backfill, order control materials and application, equipment, material disposal, temporary excavation support systems, construction dewatering, stockpiling, police details, material rehandling, surveying, or other associated items or work considered incidental to the conduct the work of this Section. Compensation for all work required under this Section and not specifically covered elsewhere, shall be included in the Contract Lump Sum Price for Earthwork. For purposes of adjusting the scope of construction see the Unit Price Schedule. Unit prices for certain types of earthwork are included in Section 012200 - UNIT PRICES. Bid form is included in Section 005422 – BID ATTACHMENT UNIT PRICES SCHEDULE.

END OF SECTION 31 20 00



SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
  - 1. Construction dewatering.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
  - 1. Section 31 20 00 – EARTH MOVING for soil materials, excavating, backfilling, and grading for the building, structures, slabs on grade, walls and foundations.
  - 2. Section 31 00 00 - EARTH WORK for excavating, backfilling, site grading, and for site utilities.
  - 3. Section 31 50 00 - EXCAVATION SUPPORT AND PROTECTION for shoring, bracing, and sheet piling of excavations.

1.3 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
  - 1. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer registered in the Commonwealth of Massachusetts, using performance requirements and design criteria indicated. All costs for delegated design shall be included in the bid price for the Work of this Section.

DEWATERING

2. Test liquids for hazardous waste at start of construction operations and provide on-site remediation as acceptable to authorities having jurisdiction.
3. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
4. Prevent surface water from entering excavations by grading, dikes, or other means.
5. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
6. Remove dewatering system when no longer required for construction.

#### 1.4 SUBMITTALS

- A. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
  1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
  2. Include a written plan for dewatering operations including control procedures to be adopted if dewatering problems arise.
- B. Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Qualification Data: For qualified Installer
- D. Field quality-control reports.
- E. Other Informational Submittals:
  1. Photographs: Show existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in dewatering work.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.
  1. Review methods and procedures related to dewatering including, but not limited to, the following:

- a. Inspection and discussion of condition of site to be dewatered including coordination with temporary erosion control measures and temporary controls and protections.
- b. Geotechnical report.
- c. Proposed site clearing and excavations.
- d. Existing utilities and subsurface conditions.
- e. Coordination for interruption, shutoff, capping, and continuation of utility services.
- f. Construction schedule. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- g. Testing and monitoring of dewatering system.
- h. Control of dewatering equipment during non-work hours.

## 1.6 PROJECT CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by the City of Framingham or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
  1. Notify City of Framingham Project Manager no fewer than two days in advance of proposed interruption of utility.
  2. Do not proceed with interruption of utility without the City of Framingham Project Manager's written permission.
  
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. The City of Framingham will not be responsible for interpretations or conclusions drawn from this data.
  1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
  2. The geotechnical report is referenced elsewhere in the Project Manual.
  
- C. Survey Work: Engage a qualified land surveyor or professional engineer licensed in the Commonwealth of Massachusetts to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
  1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Designer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
  - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
  - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the City of Framingham Project Manager and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Monitor dewatering systems continuously.
- E. Promptly repair damages to adjacent facilities caused by dewatering.
- F. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 31 25 00 - EROSION AND SEDIMENTATION CONTROLS during dewatering operations.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
  - 1. Space well points or wells at intervals required to provide sufficient dewatering.
  - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient

dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.
- E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to the City of Framingham.
1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.
- G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

### 3.3 FIELD QUALITY CONTROL

- A. Observation Wells: Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated; additional observation wells may be required by authorities having jurisdiction.
1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
  2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
  3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

END OF SECTION

SECTION 31 25 00

EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
1. Control measures to prevent all erosion, siltation and sedimentation of wetlands, waterways, construction areas, adjacent areas and off-site areas.
  2. Control measures shall be accomplished adjacent to or in the following work areas:
    - a. Soil stockpiles and on-site storage and staging areas.
    - b. Cut and fill slopes and other stripped and graded areas.
    - c. Constructed and existing swales and ditches.
    - d. Retention ponds.
    - e. At edge of wetlands areas, if applicable, as shown on Drawings.
  3. Additional means of protection shall be provided by the Contractor as required for continued or unforeseen erosion problems, at no additional cost to the City of Framingham.
  4. Periodic maintenance of all sediment control structures shall be provided to ensure intended purpose is accomplished. Sediment control measures shall be in working condition at the end of each day.
  5. After any significant rainfall, sediment control structures shall be inspected for integrity. Any damaged device shall be corrected immediately.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. Section 312000 - EARTH MOVING for soil materials, excavating, backfilling, and grading for the building, structures, slabs on grade, walls and foundations.
  2. Section 311000 - SITE CLEARING for protection of existing trees and other vegetation to remain.

3. Section 310000 - EARTH WORK for soil materials, excavating, backfilling, and site grading and removal of site utilities.

### 1.3 QUALITY ASSURANCE

- A. When applicable, comply with the requirements of Stormwater Pollution Prevention Plan prepared for the NPDES permit, which are incorporated herein by reference, and all other applicable requirements of governing authorities having jurisdiction. The specifications and drawings are not represented as being comprehensive, but rather convey the intent to provide complete slope protection and erosion control for both the project site and adjacent property.
  1. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to a sediment and erosion control plan specific to the site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
  2. Regulatory Order of Conditions ((Attach to the end of this Section, when applicable))
- B. Erosion control measures shall be established at the beginning of construction and maintained during the entire period of construction. On-site areas which are subject to severe erosion, and off-site areas which are especially vulnerable to damage from erosion and/or sedimentation, are to be identified and receive special attention.
- C. All land-disturbing activities are to be planned and conducted to minimize the size of the area to be exposed at any one time, and the length of time of exposure.
- D. Surface water runoff originating upgrade of exposed areas should be controlled to reduce erosion and sediment loss during the period of exposure.
- E. When the increase in the peak rates and velocity of storm water runoff resulting from a land-disturbing activity is sufficient to cause accelerated erosion of the receiving stream bed, provide measures to control both the velocity and rate of release so as to minimize accelerated erosion and increased sedimentation of the stream.
- F. All land-disturbing activities are to be planned and conducted so as to minimize off-site sedimentation damage.
- G. The Contractor is responsible for cleaning out and disposing of all sediment once the storage capacity of the sediment facility is reduced by one-half.
- H. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- I. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Straw Bales: Wire or nylon bound bales of straw, oriented around sides, rather than over and under.
- B. Straw wattles shall be made of straw of oats, wheat, barley, rye, or natural straw inside a flexible and durable tubular netting with metal clips or knotted ends, and shall be utilized to control sediment runoff during construction activities. The minimum size for the straw wattles is 12-inch diameter. Furnish oak wood stakes 2 inch x 2 inch x 4 feet long or 1/2 inch x 4 feet long rebar with safety caps.
- C. Stakes: Stakes for bales shall be one of the following materials: Wood stakes of sound hardwood 2 by 2 inches in size or steel reinforcing bars of at least No. 4 size. Lengths shall be approximately three feet.
- D. Siltation Fence: Fabricated or prefabricated unit consisting of the following filter fabric properties:
- |  |       |                       |
|--|-------|-----------------------|
| 1. Grab Tensile Strength               | 90    | ASTM D1682            |
| 2. Elongation at Failure (%)           | 50    | ASTM D1682            |
| 3. Mullen Burst Strength (PSI)         | 190   | ASTM D3786            |
| 4. Puncture Strength (lbs)             | 70    | ASTM D751 (modified)  |
| 5. Slurry Flow Rate (gal/min/sf)       | 0.5   | Virginia DOT VTM-51   |
| 6. Equivalent Opening Size             | 40-80 | US Std Sieve CW-02215 |
| 7. Ultraviolet Radiation Stability (%) | 90    | ASTM G26              |
- E. Fencing: Steel posts shall be standard 6 foot long metal stamped drive stakes commonly used to support snow fences. Fencing shall be new four foot height wood lath snow fencing. Provide suitable steel staples or heavy nylon cord for securing filter cloth to support system.
- F. Protective Measures: As temporary coverings on ground areas subject to erosion, provide one of the following protective measures, and as directed by the Architect with concurrence of the City of Framingham:
1. Hay or straw temporary mulch, 100 pounds per 1,000 square feet.
  2. Wood fiber cellulose temporary mulch, 35 pounds per 1,000 square feet.
  3. Tackafier for anchoring mulch or straw shall be a non-petroleum based liquid bonding agent specifically made for anchoring hay or straw.
  4. Provide natural (jute, wood excelsior) or man-made (glass fiber) covering with suitable staples or anchors to secure to ground surface. Note that wire stapes and non-biodegradable coverings shall not be used for any area that will be mown turf.
  5. Temporary vegetative cover for graded areas shall be undamaged, air dry threshed straw or hay free of undesirable weed seed.



## PART 3 - EXECUTION

### 3.1 STRAW BALE BARRIERS

- A. Excavation shall be to the width of the bale and the length of the proposed barrier to a minimum depth of 4 inches.
- B. Bales shall be placed in a single row, lengthwise on proposed line, with ends of adjacent bales tightly abutting one another. In swales and ditches the barrier shall extend to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale.
- C. Staking shall be accomplished to securely anchor bales by driving at least two stakes or rebars through each bale to a minimum depth of 18 inches.
- D. The gaps between bales shall be filled by wedging straw in the gaps to prevent water from escaping between the bales.
- E. The excavated soil shall be backfilled against the barrier. Backfill shall conform to ground level on the downhill side and shall be built up to 4 inches on the uphill side. Loose straw shall then be scattered over the area immediately uphill from a straw barrier.
- F. Inspection shall be frequent and repair or replacement shall be made promptly as needed.

### 3.2 STABILIZED CONSTRUCTION ENTRANCE AND STONE BERMS

- A. Stone size: Use ASTM designation C-33, size No. 2 (1-1/2" to 2-1/2"). Use crushed stone.
- B. Length: As effective, but not less than 50 feet.
- C. Thickness: Not less than eight inches.
- D. Width: Not less than full width of all points on ingress or egress, but not less than 25 feet.
- E. Washing: When necessary, wheels shall be cleaned to remove sediment prior to entrance onto public right-of-way. When washing is required, it shall be done on an area stabilized with crushed stone which drains into an approved sediment trap or sediment basin. All sediment shall be prevented from entering any storm drain, ditch, or watercourse through the use of sand bags, gravel boards or other approved methods.
- F. Maintenance: The entrance shall be maintained in a condition which will prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top dressing with additional stone as conditions demand and repair and/or cleanout of any measures used to trap sediment. All sediment spoiled, dropped, washed or tracked onto public rights-of-way must be removed immediately.

- G. Place crushed stone berms in locations required and as directed. Berms shall have side slopes of 1:3 or less.
- H. Inspect stone berms periodically and replace and/or regrade crushed stone as required.

### 3.3 SILT FENCING

- A. Excavate a 6 inch trench along the upstream side of the desired fence location.
- B. Drive fence posts a minimum of 1'-6" into the ground. Install fence, well-staked at maximum eight foot intervals in locations as shown on Drawings. Secure fabric to fence and bury fabric end within the six inch deep trench cut.
- C. Lay lower 12 inches of silt fence into the trench, 6 inches deep and 6 inches wide. Backfill trench and compact.
- D. Overlap joints in fabric at post to prevent leakage of silt at seam.

### 3.4 EROSION CONTROL GRASSING

- A. Grassing shall be applied according to State of Massachusetts Highway Department Standard Specifications.

### 3.5 INLET PROTECTION

- A. Install silt fence or straw bales around inlet as specified herein.

### 3.6 DUST CONTROL

- A. Throughout the construction period the Contractor shall carry on an active program for the control of fugitive dust within all site construction zones, or areas disturbed as a result of construction. Control methods shall include the following: Apply calcium chloride at a uniform rate of one and one-half (1-1/2) pounds per square yard in areas subject to blowing. For emergency control of dust apply water to affected areas. The source of supply and the method of application for water are the responsibility of the contractor.
- B. The frequency and methods of application for fugitive dust control shall be as directed by the Architect with concurrence by the City of Framingham.

### 3.7 TEMPORARY PROTECTIVE COVERINGS (AFTER GROWING SEASON)

- A. Place temporary covering for erosion and sedimentation control on all areas that have been graded and left exposed after October 30. Contractor shall have the choice to use either or both of the methods described herein.

- B. Hay or straw shall be anchored in-place by one of the following methods and as approved by the Architect with concurrence by the City of Framingham: Mechanical “crimping” with a tractor drawn device specifically devised to cut mulch into top two inches of soil surface or application of non-petroleum based liquid tackifier, applied at a rate and in accordance with manufacturer’s instructions for specific mulch material utilized.
- C. Placement of mesh or blanket matting and anchoring in place shall be in accordance with manufacturer’s printed instructions.
- D. Inspect protective coverings periodically and reset or replace materials as required.

END OF SECTION

SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
  - 1. Temporary excavation support and protection systems.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
  - 1. Section 31 23 19 - DEWATERING for dewatering system for excavations.

1.3 PERFORMANCE REQUIREMENTS

- A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
  - 1. Provide professional engineering services needed to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer registered in the Commonwealth of Massachusetts.
  - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
  - 3. Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements adjacent to excavation.
  - 4. Provide vibration monitoring to prevent impacts on adjacent structures and utilities.

#### 1.4 SUBMITTALS

- A. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.
  - 1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Qualification Data: For Installer and professional engineer.
- C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

#### 1.5 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.
  - 1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:
    - a. Geotechnical report.
    - b. Existing utilities and subsurface conditions.
    - c. Proposed excavations.
    - d. Proposed equipment.
    - e. Monitoring of excavation support and protection system.
    - f. Working area location and stability.
    - g. Coordination with waterproofing.
    - h. Abandonment or removal of excavation support and protection system.

#### 1.6 PROJECT CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
  - 1. Notify the City of Framingham Project Manager no fewer than two days in advance of proposed interruption of utility.
  - 2. Do not proceed with interruption of utility without The City of Framingham Project Manager's written permission.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. The City of Framingham will not be responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
  2. The geotechnical report is referenced elsewhere in the Project Manual.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Designer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
- C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
- D. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- F. Timber Piling: ASTM D 25, species listed in AWPA C3, pressure-treated in accordance with AWPA C3.
- G. Seven Wire Strand: ASTM A 416, Grade 250 or 270., uncoated seven-wire, low-relaxation strand.
- H. Grout: Suitable for service, minimum 4,000 psi.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
  1. Shore, support, and protect utilities encountered.

- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the City of Framingham Project Manager and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

### 3.2 SOLDIER BEAMS AND LAGGING

- A. Install steel soldier beams before starting excavation. Space soldier beams at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- B. Install wales horizontally at spacings indicated on the approved shop drawings and secure to soldier beams.

### 3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

### 3.4 TIEBACKS

- A. Tiebacks: Drill for, install, grout, and tension tiebacks into position. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
  - 1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
  - 2. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.
  - 3. Inspect tiebacks periodically to confirm anchors exhibit no movement.

### 3.5 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
  - 1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise approved by Engineer.
  - 2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
  - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

### 3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
  - 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
  - 2. Fill voids immediately with approved backfill compacted to density specified in Section 31 20 00 - EARTH WORK or 31 00 00 – EARTH MOVING, as applicable.
  - 3. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION



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Section 31 63 17

GROUND IMPROVEMENT – AGGREGATE PIER AND RIGID INCLUSION

**PART 1 - GENERAL**

1.1 DESCRIPTION

- A. Work shall consist of designing, furnishing and installing Rammed Aggregate Pier (RAP) and/or Rigid Inclusion (RI) ground improvement to the lines and grades designated on the project foundation plans and related quality control testing and performance testing as specified herein. The work shall also consist of providing inspection and certification of the construction of load transfer platform prior to foundation and slab construction. RAP elements shall be in a columnar-type configuration and shall be used for support of footing and slab-on-grade loads. RAP elements shall be constructed by either augering a cavity or driving a hollow mandrel to the design depth and vertically ramming lifts of aggregate using the specially designed tamper head and high-energy impact densification equipment to create the compacted aggregate pier. Rigid Inclusions are columns of grout used to reinforce the round to increase bearing capacity and reduce settlement of a structure of embankment. Rigid Inclusions are constructed using an auger displacement tool or vibrated pipe tool that displaces soil laterally, producing very little spoils.

1.2 WORK INCLUDED

- A. Provision of all equipment, material, labor and supervision to design and install RAP and/or RI elements. Design shall rely on subsurface information presented in the project geotechnical report by RSE Associates dated 3 May 2019. Survey layout RAP/RI elements, spoil removal (as required), footing excavations, and foot/slab subgrade preparation following RAP/RI installation is not included.
- B. The RAP/RI design and installation shall adhere to all methods and standards described in the Specification.
- C. Drawings and General Provisions of the Contract, including General and Supplemental Conditions, and Division 1 Specifications, apply to the work in this specification.

1.3 APPROVED INSTALLERS

- A. The RAP/RI (the Installer) shall be approved by the Owner's Geotechnical Representative (RSE Associates) prior to bid opening. Without exception, no alternate installer will be accepted unless approved by the Owner's Geotechnical Representative at least two (2) weeks prior to bid opening. The Owner's Geotechnical Representative is hereinafter referred to as "Geotechnical Representative".
- B. Installers shall have a minimum of 5 years of experience with the installation of RAP systems, completed at least 50 RAP projects in New England, and completed at least 10 RAP projects in the Commonwealth of Massachusetts.

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- C. Installers licensed by the Geopier Foundation Company, Inc. ([www.geopier.com](http://www.geopier.com)) are hereby accepted as approved installers.

#### 1.4 REFERENCE STANDARDS

##### A. Design

1. "Control of Settlement and Uplift of Structures Using Short Aggregate Piers," by Evert C. Lawton (Assoc. Prof., Dept. of Civil Eng., Univ. of Utah), Nathaniel S. Fox (President, Geopier Foundation Co., Inc.), and Richard L. Handy (Distinguished Prof. Emeritus, Iowa State Univ., Dept. of Civil Eng.), reprinted from *IN-SITU DEEP SOIL IMPROVEMENT, Proceedings of sessions sponsored by the Geotechnical Engineering Division/ASCE in conjunction with the ASCE National Convention held October 9-13, 1994, Atlanta, Georgia*.
2. "Settlement of Structures Supported on Marginal or Inadequate Soils Stiffened with Short Aggregate Piers," by Evert C. Lawton and Nathaniel S. Fox. *Geotechnical Special Publication No. 40: Vertical and Horizontal Deformations of Foundations and Embankments*, ASCE, 2, 962-974.
3. "Technical Bulletin No. 12, Proper Load Testing Procedures to Verify Adequate Design of Geopier-Supported Foundation Systems," by Kord Wissmann and W. Lake Carter, Geopier Foundation Company, Inc. ©2015.

##### B. Modulus Testing

1. ASTM D 1143 - Pile Load Test Procedures
2. ASTM D 1194 - Spread Footing Load Test

##### C. Materials and Inspection

1. ASTM D 1241 - Aggregate Quality
2. ASTM D 422 - Gradation of Soils

- D. Where specifications and reference documents conflict, the RAP/RI Design Engineer (the Designer) shall make the final determination of the applicable document.

#### 1.5 DESCRIPTION

- A. Qualifications – With reference to Paragraph 1.3.B, the Installer shall submit the following with their proposal to document/demonstrate the minimum experience requirements for this project.
1. Documentation verifying a minimum of 50 previous projects completed in New England, including at least 10 successful projects where subsurface conditions included an organic layer (peat or organic silt) thickness of at least 3- to 10-feet-thick within the ground improvement zone. For the minimum 10 projects with organic layers within the ground improvement zone, the Installer shall submit references with contact information for the Geotechnical Representative and General Contractor.
  2. For the minimum 10 previous projects completed in the Commonwealth of Massachusetts, the Installer shall submit references with contact information for the Geotechnical Representative and General Contractor.

- B. Design Submittal - The Installer shall submit detailed design calculations and construction drawings prepared by the Designer for review and approval by the Geotechnical Representative and the project Structural Engineer. All plans shall be sealed by a Professional Engineer licensed in the Commonwealth of Massachusetts. The submittal shall include grout/cement mix design as applicable.
- C. Professional Liability Insurance - The Designer shall have Errors and Omissions design insurance for the work. The insurance policy should provide a minimum coverage of \$3 million per occurrence.
- D. Modulus Test Reports - A modulus test(s) shall be performed on minimum of one non-production RAP and one non-production RI element, if used, as required by the Designer to verify the design assumptions. The Installer shall furnish the General Contractor a description of the installation equipment, installation records, complete test data, analysis of the test data and verification of the design parameter values based on the modulus test results. The report shall be prepared under direction of a Registered Professional Engineer licensed in the Commonwealth of Massachusetts.
- E. Daily RAP/RI Progress Reports - The Installer shall furnish a complete and accurate record of RAP/RI installation to the General Contractor. The record shall indicate the element location, length, volume of aggregate used or number of lifts, densification forces during installation, and final elevations or depths of the base and top of elements. The record shall also indicate the type and size of the installation equipment used, and the type of aggregate used. The Installer shall immediately report any unusual conditions encountered during installation to the General Contractor, the Designer, and the Geotechnical Engineer.

## **PART 2 - PRODUCTS**

### **2.1 AGGREGATE**

- A. Aggregate used by the Installer for element construction shall be pre-approved by the Designer and shall demonstrate suitable performance during modulus testing. Typical aggregate consists of Type 1 Grade B in accordance with ASTM D-1241-68, No. 57 stone, or other graded aggregate approved by the Designer.
- B. Clean, potable water or other suitable source shall be used to mix grout and increase aggregate moisture content where required. The General Contractor shall provide such water to the Installer.

### **2.2 GROUT/CEMENT**

- A. For RI elements, grout shall consist of a homogeneous mixture of Portland Cement conforming to the ASTM Standard C150/C150M, sand, and clean, potable water. Documentation for other additives shall be submitted for review. The components shall be proportioned and mixed to produce a grout capable of maintaining the solids in suspension, minimizing bleed and being pumped without difficulty. The required grout strength shall be determined by the Designer.
- B. RAP elements constructed with cement-treated aggregate (CTA) or grout will not be allowed.

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2.3 REINFORCING STEEL

- A. Reinforcing steel, if required, shall conform to the requirement of Designer.

2.4 GEOGRID/GEOTEXTILE

- A. Geogrid and geotextile, if required per Designer., shall conform to and be installed in accordance with manufactures specifications and guidelines, as per details in RAP/RI Design Drawings.

**PART 3 – DESIGN REQUIREMENTS**

3.1 RAP/RI DESIGN

- A. The RAP system shall be designed in accordance with locally-accepted engineering practice and the methods described in Section 1 of these Specifications. The design life of the structure shall be 75 years.
- B. The design shall meet the following performance criteria:

**Footings**

*Maximum Allowable Bearing Pressure for Footings Supported by RAP Reinforced Soils	4,000 psf
Total Settlement for Footings:	≤ 1-inch
Differential Settlement of Adjacent Footings:	≤ ½-inch

**Slab-on-Grade**

Slab-on-grade carrying load	450 psf
Settlement of Slabs-on-Grade:	≤ ½-inch
Differential Settlement of slab-on-grade:	≤ ¼-inch

**Amphitheater within 30 ft of Building**

Settlement of Amphitheater:	≤ ½-inch
Differential Settlement of Amphitheater:	≤ ¼-inch

- C. If fully grouted/cemented elements (Rigid Inclusions) are proposed in lieu of ungrouted/uncemented RAP elements, then a granular Footing Pad (or “Load Transfer Platform”) shall be required below all footings and slabs to be supported by Rigid Inclusions. The system shall be designed and perform to limit penetration (punching) of ground improvement elements into the Footing Pad.
- D. If any boring (or other exploration) with the proposed building footprint indicates an organic layer (peat or organic silt) and/or soft clay layer that is ≥ 3-feet-thick within the ground improvement zone, the RAP design submittal for the slab-on-grade shall include a Finite Element Analysis (FEA) to demonstrate that the maximum bending moment and maximum shear stress at the midpoint of the most widely-

spaced slab support RAP elements are within tolerances specified by the project Structural Engineer. For the FEA, the minimum RAP stiffness modulus value shall be determined based on modulus testing (see Section 5.02). The stiffness modulus value shall be reduced exponentially for each foot of radial distance away from the edge of the RAP element in accordance with a referenced industry-accepted standard(s).

- E. The Rammed Aggregate Pier elements shall be designed using a Rammed Aggregate Pier stiffness modulus to be verified by the results of the modulus test described in Section 5.02.

### 3.2 DESIGN SUBMITTAL

- A. The Installer shall submit detailed design calculations, construction drawings, and shop drawings, (the Design Submittal), for review and approval at least 2 week(s) prior to the beginning of construction.
- B. The design information shall include, but not be limited to, element configurations, materials, capacity and spacing, details and design of Footing Pads/Load Transfer Platform (if Footing Pads are required), bearing capacity analysis, settlement analyses, global stability analysis (if necessary), explanation of assumed soil properties, element installation termination criteria, embedment depth into the bearing stratum, and all other relevant information.
- C. With reference to paragraph 5.02.C, the design calculations shall quantify the RAP element's maximum design stress on an individual element (which attracts more stress than the surrounding matrix soil) and is typically at least 3 to 5 times the allowable bearing pressure for footings.
- D. A detailed explanation of the design parameters for settlement calculations shall be included in the Design Submittal.
- E. If Rigid Inclusions elements are proposed, the Installer shall submit information demonstrating the integrity of the grouted/cemented shaft based on prior or newly proposed full-scale field testing, exhumation of shafts, or similar methods.
- F. If Rigid Inclusions (which require Footing Pads) are proposed, the Installer shall submit information demonstrating the performance of the proposed Footing Pad design based on prior or newly proposed full-scale testing, including demonstrating that excessive punching will not occur per paragraph 3.01.C.
- G. The quality control test program for the RAP system, meeting the design requirements described herein, shall be submitted.
- H. All calculations and drawings shall be prepared and sealed by a Professional Engineer licensed in the Commonwealth of Massachusetts.
- I. Submittals shall be submitted electronically only unless otherwise required by specific submittal instructions.

## **PART 4 – EXECUTION**

### **4.1 SITE VISIT**

Site visits are necessary in order to be aware of conditions at the work site.

- A. Pre Bid Site Visit: Prior to submitting a bid price for the RAP/RI program, the RAP/RI contractor shall visit the site during the project prebid meeting to identify readily visible conditions in order to account for them in the bid.
- B. Existing Structures: Prior to initiating work, a condition survey of structures in the immediate vicinity of the work shall be performed by the General Contractor to determine that the conditions are safe to perform the specified work. The structure(s) must be examined prior to initiating work to document preexisting cracks/damage. The structure(s) must also be monitored for movement during any work within 25 feet of the structure(s). The work shall be stopped and the engineer notified if any negative structural impacts are observed (settlement, increase in crack width, etc.).

### **4.2 SITE PREPARATION**

The following shall be performed by the General Contractor in support of the RAP/RI Contractor:

- A. Removal of all surface or subsurface topsoil, brush, organic material, and other unacceptable material in accordance with the requirements of the contract documents. Removal of any surface or subsurface obstructions to the RAP/RI work.
- B. Site shall be graded to an agreed working elevation. A dry, level, and stable working platform shall be provided and maintained throughout the work. Platform stability should be evaluated and certified by the owner's geotechnical engineer and the general contractor, based on equipment information provided by the specialty contractor.
- C. Provision of all-weather access and maintenance thereof for the RAP/RI Contractor's equipment and workforce, and for delivery of materials to the worksite.
- D. Horizontal and vertical survey control and survey layout of building corners, grid lines, footing locations, embankment limits, utilities etc., for reference by the RAP/RI Contractor for layout and performance of the RAP/RI work.

### **4.3 APPROVED INSTALLATION PROCEDURES**

The following sections provide general criteria for the construction of the RAP/RI elements. Unless otherwise approved by the Designer, the installation method used for RAP/RI element construction shall be that as used in the construction of the successful modulus test.

- A. General
  - 1. The Installer shall provide a qualified, full-time, solely-dedicated, quality control (QC) person on-site during the installation process. The QC person

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shall not be dual-purposed as crew laborer or operator. Automated, electronic, and/or remote quality control will not be accepted as a replacement for the QC person. Refer to Section 5.01 for further detail.

2. The explorations indicate the presence of a continuous (or sporadic/intermittent) organic layer (peat or organic silt) and/or soft clay layer within the ground improvement zone that is 2-feet to 10-feet thick. The ground improvement design/approach shall include RI elements through such layers below all footings to account for the possibility that such layers could be encountered anywhere within the proposed building footprint, not only in localized areas. The Designer/Installer may choose to RI elements more frequently than these minimum requirements, such as below slab areas and/or below footings where the organic and/or soft clay layer is less than 3-foot-thick.
3. In addition to peat and organic silt layers, fill with a total organic content (including solid wood or roots component) greater than 10% shall be considered an organic layer.
4. At a minimum, RAP/RI elements must be designed and installed to fully-penetrate through the fill and organics layers and minimum of 1-foot into underlying natural glacial lacustrine and glacial outwash. RAP/RI elements terminating within fill or organic soil layers will not be accepted, even if mandrel/probe resistance is demonstrated to be relatively high based on crowd testing or amperage build-up.
5. Vibration levels at existing buildings must be maintained below 0.5 inches per second.

B. RAP Elements Installed Using Displacement Installation Methods

1. Displacement RAP systems shall be constructed by advancing a specially designed mandrel with a minimum 15 ton static force augmented by dynamic vertical ramming energy to the full design depth. The hollow-shaft mandrel, filled with aggregate, is incrementally raised, permitting the aggregate to be released into the cavity, and then lowered by vertically advancing and/or ramming to densify the aggregate and force it laterally into the adjacent soil. The cycle of raising and lowering the mandrel is repeated to the top of RAP element elevation. The cycle distance shall be determined by the Designer.
2. Special high-energy impact densification apparatus shall be employed to vertically densify the RAP elements during installation of each constructed lift.
3. Densification shall be performed using a mandrel/tamper. The mandrel/tamper foot is required to adequately increase the lateral earth pressure in the matrix soil during installation.
4. Downward crowd pressure shall be applied to the mandrel during installation.
5. Pre-augering may be used to help the mandrel penetrate through relatively dense soil areas.

C. RI shall be constructed in accordance with and at locations as shown on approved design and shop drawings.

1. The RI tool shall be advanced to design depth or tool refusal. During grouting the RI tool shall be filled with a grout volume adequate to maintain a positive grout head for the RI withdrawal of the tool. Grout is placed fully to the final RI cutoff elevation.

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2. The grout shall be supplied at a sufficient rate during tool withdrawal to ensure that a continuous element of the full specified cross-section is formed, free from debris. The depth of the tool and volume of grout shall be measured and recorded for each element. If the grout placement in any element cannot be completed as described above, then the element shall be re-penetrated before grout has hardened and grout placed to the final RI cutoff elevation or the RI shall be completely replaced.
  3. Obstructions: Obstructions encountered during advancement of the RI tool that will prevent installation to the design depth, or cause the RI tool to redirect from its design location during installation shall be removed.
  4. Obstruction include, but are not limited to: boulders, timbers, concrete, bricks, utility lines, etc. that prevent advancement of the RI tool to the required depth or cause the RI tool to redirect from the design location. Dense natural soil, natural rock or weathered rock shall not be considered obstructions. The RI design engineer shall be notified within 24 hours of any obstructions or unexpected early refusal to verify the revised location and/or depth are acceptable.
  5. Diameter of RIs: The RIs shall be constructed to the diameter shown on the project drawings or the approved shop drawings.
  6. Depth of work: The RIs shall be constructed to the depth/elevation shown on the approved shop. RI installation rigs shall be equipped with instrumentation to measure, display and record the tool penetration rate versus depth.
  7. Grout shall be cast to the final RI cutoff elevation unless otherwise specified. If necessary, to protect Rigid Inclusions from damage due to subsequent construction activities, elements shall be dipped out prior to initial set and backfilled with gravel or granular fill. Alternatively, a steel reinforcing member may be installed into the upper portion of the element to protect against damage
- D. Subsequent Construction: A Load Transfer Platform (LTP) shall be constructed over the RI heads to transfer the design loads to the elements
1. The LTP shall be constructed of a specified granular material and may be reinforced with one or more layers of biaxial geogrid and/or geotextile as shown in the approved RI design and shop drawings.
  2. Construction of the LTP shall not commence until the compressive strength of the grout has reached a value provided by the Designer. LTP material, lift thickness, and compaction shall conform to the approved RAP/RI design and shop drawings. Testing requirements shall be equal to those required by the project geotechnical engineer of record. Materials shall conform to those specified in the approved RAP/RI design and shop drawings.
  3. Construction of the LTP shall be installed in a manner as to avoid direct contact with cured rigid inclusions. The RAP/RI Contractor and RAP/RI Design Engineer shall be notified if any heavy machinery makes contact with a cured RI during LTP construction or excessive rutting is experienced adjacent to cured RIs. Replacement RIs may be required if RIs are damaged during LTP construction. Cost of construction of the replacement RI shall be borne by the General Contractor or LTP installer.
  4. The General Contractor's inspector and RAP/RI's Design Engineer shall monitor LTP construction. Compaction shall be performed and accomplished



as specified in the contract drawings for structural fill or LTP construction. Reinforcement and concrete placement shall be performed in a timely manner so that no degradation of the bearing surface occurs. In the case of foundation construction, if foundation concrete cannot be placed on the same day that excavation takes place, then a minimum 3-inch thick mud mat shall be placed immediately following approval of the footing excavation and LTP construction.

#### 4.2 PLAN LOCATION AND ELEVATION OF RAP ELEMENTS

The as-built center of each RAP/RI element shall be within 6 inches of the locations indicated on the plans.

#### 4.3 REJECTED RAP ELEMENTS

RAP/RI elements installed beyond the maximum allowable tolerances shall be abandoned and replaced with new elements, unless the Designer approves the condition or provides other remedial measures. All material and labor required to replace rejected elements shall be provided at no additional cost to the Owner, unless the cause of rejection is due to an obstruction or mislocation.

### **PART 5 – QUALITY CONTROL**

#### 5.1 QUALITY CONTROL TECHNICIAN

The Installer shall have a qualified, full-time, solely-dedicated, quality control (QC) person to verify and report all installation procedures. The Installer shall immediately report any unusual conditions encountered during installation to the Designer, the General Contractor, and to the observing Geotechnical Representative. The quality control procedures shall include the preparation of RAP/RI Progress Reports completed during each day of installation containing the following information:

- A. Footing and RAP/RI element location with identification number of the pier.
- B. Pre-auger diameter and soil conditions encountered during drilling (if required).
- C. RAP/RI element length.
- D. Planned and actual RAP/RI element elevations at the top and bottom of the element.
- E. Average lift thickness of each RAP/RI element.
- F. Volume of aggregate used in each element.
- G. The maximum amperage drawn by the electric motor (if compaction equipment used)
- H. Continuous depth/amperage if available (if compaction equipment used)
- I. Documentation of any unusual conditions encountered.
- J. Type and size of densification equipment used.

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## 5.2 SINGLE-ELEMENT RAP MODULUS TEST(S)

A minimum of one single-element RAP Modulus Test and one single-element RI Modulus Test, if used, shall be performed at a location agreed upon by the Designer and the Geotechnical Representative to verify or modify the RAP/RI design. The modulus tests shall be of the type and installed in a manner specified herein.

- A. Modulus test procedures shall utilize appropriate portions of ASTM D 1143 and ASTM D 1194 and comply with Technical Bulletin No. 12 (Wissmann and Carter, 2015).
- B. The test plate/cap shall have the same diameter as the RAP/RI element design diameter and shall not extend beyond the edge of the RAP/RI element and over the matrix soil.
- C. With reference to Technical Bulletin No. 12 (Wissmann and Carter, 2015), the test element shall be tested to a load equal to the element area times at least 150 percent of the RAP element's maximum design stress (not allowable bearing pressure for footings) to demonstrate that the element exhibits safe response during service loading. The RAP element's maximum design stress is the maximum stress on the individual element (which attracts more stress than the surrounding matrix soil) and is typically at least 3 to 5 times the allowable bearing pressure for footings. Single-element modulus tests that are proposed to be loaded as a function of allowable bearing pressure are not considered standard practice and will not be accepted since the allowable bearing pressure is often only a fraction of the RAP element's maximum design stress. Modulus tests that are proposed to be loaded as a function of allowable bearing pressure shall be performed per Paragraph 5.02.1.
  - 1. If Rigid Inclusions are proposed in lieu of ungrouted/uncemented and subgrade soils at the bottom of the footing (or footing pad) consist of organic soils and/or soft to very soft cohesive soils, then the Rigid Inclusion design capacity shall conservatively be calculated using the total bottom-of-footing load divided by the number of Rigid Inclusions.
  - 2. If Rigid Inclusions are proposed in lieu of ungrouted/uncemented, then the Rigid Inclusion test element shall be tested to at least 200 percent of the Rigid Inclusion design capacity to demonstrate that the element exhibits safe response during service loading.
  - 3. If Rigid Inclusions are proposed in lieu of ungrouted/uncemented, then a granular Footing Pad shall be required below all footings and slabs to be supported by Rigid Inclusions. The Footing Pad shall be designed by the Designer and shall be at least 12-inches-thick.
- D. A telltale shall be installed at the bottom of the test element so that bottom-of-element deflections may be determined. For ungrouted/uncemented RAP elements, acceptable performance is indicated when the bottom of the element deflection is no more than 30% of the top of element deflection at the design stress level.

- E. ASTM D-1143 general test procedures shall be used as a guide to establishing load increments, load increment duration, and load decrements. As a minimum, the following loading increments, decrements and duration shall be used.

<u>Increment</u>	<u>Approximate Load</u> (percent design)	<u>Minimum Duration (min)</u>	<u>Maximum Duration (min)</u>
Seat	< 9	0	N/A
1	17	15	60
2	33	15	60
3	50	15	60
4	67	15	60
5	83	15	60
6	100	15	60
7	117	60	120
8	133	15	60
9	150	15	60
10	100	N/A	N/A
11	66	N/A	N/A
12	33	N/A	N/A
13	0	N/A	N/A

- F. With the exception of the load increment representing approximately 117% of the RAP element maximum design stress, all load increments shall be held for a minimum of 15 minutes. Loads are then maintained until the rate of deflection reduces to 0.01 inch per hour or for the maximum of 1 hour, whichever is occurs first.
- F. Creep Test - The load increment that represents approximately 117% of the RAP element maximum design stress shall be held for a minimum of 15 minutes. Loads are then maintained until the rate of deflection reduces to 0.01 inch per hour or for the maximum of 4 hours, whichever is occurs first.
1. If Rigid Inclusions are proposed in lieu of ungrouted/uncemented or partially grouted/cemented RAP elements, then the creep test shall be performed at the load increment that represents approximately 133% of the RAP element maximum design stress.
- H. A seating load equal to 5 percent of the total load shall be applied to the loaded steel plate prior to application of load increments and prior to measurement of deflections to compensate for surficial disturbance.
- I. Single-element modulus tests that are proposed to be loaded as a function of allowable bearing pressure are not considered standard practice and will not be accepted. Modulus tests that are proposed to be loaded as a function of allowable bearing pressure must consist of full-scale spread footing load tests that include a test footing supported by a minimum of three RAP elements and having a RAP area-replacement ratio (AreaRAPs/AreaFootings) that is representative of the smallest area replacement ratio used in the RAP design. The test spread footing

shall be loaded to at least 200 percent of the allowable bearing pressure to demonstrate that the RAP-supported footing exhibits safe response during service loading.

5.3 BOTTOM STABILIZATION TESTING (BSTs)/CROWD STABILIZATION TESTING (CSTs)

Bottom stabilization testing (BSTs) or Crowd stabilization testing (CSTs) shall be performed by the Quality Control Technician during the installation of the modulus test element. Additional testing as required by the Designer shall be performed on selected production RAP elements to compare results with the modulus test element.

**PART 6 –QUALITY ASSURANCE**

6.1 Designer's Quality Assurance

The Installer shall provide full-time Quality Control monitoring of RAP construction activities. The RAP/RI Designer shall provide Quality Assurance services.

6.2 Responsibilities of Designer's Quality Assurance

- A. The Designer shall monitor the modulus test element installation and testing. The Installer shall provide and install all dial indicators and other measuring devices.
- B. The Designer shall monitor the installation of RAP elements to verify that the production installation practices are similar to those used during the installation of the modulus test element(s).
- C. With reference to Paragraph 4.01.A.5, the Designer shall monitor vibrations and immediately report to the Installer and General Contractor if specified tolerances are exceeded.
- D. The Designer shall report any discrepancies to the Installer and General Contractor immediately.
- E. The Designer shall observe the excavation and compaction/preparation of subgrade prior to placement of the foundations as described in Section 7.05.

**PART 7 – RESPONSIBILITIES OF THE GENERAL CONTRACTOR**

7.1 Site Preparation and Protection

- A. The General Contractor shall locate and protect underground and aboveground utilities and other structures from damage during installation of the RAP elements.
- B. Site grade for RAP/RI installation shall be at El. 165.5 to El. 166.5. Ground elevations and bottom of footing elevations shall be provided to the Installer in sufficient detail to estimate installation depth elevations to within 3 inches.

- C. The General Contractor will provide site access to the Installer, after site preparation in the area has been completed. A flat and stable working pad subgrade shall be established and maintained by the General Contractor to provide wet weather protection of the subgrade and to provide access for efficient operation of the RAP installation. Preparation of a flat and stable working pad may include placement of crushed stone and geotextile fabric. Any excavation or backfilling that occurs for working pad preparation shall be in accordance with the Designer's submittal.
- D. Prior to, during and following RAP/RI installation, the General Contractor shall provide positive drainage to protect the site from wet weather and surface ponding of water.
- E. If spoils are generated by RAP/RI installation, spoil removal from the RAP/RI work area in a timely manner to prevent interruption of RAP/RI installation is required.

## 7.2 RAP/RI LAYOUT

The location of individual RAP/RI elements shall be marked in the field using flagged and numbered whiskers at locations shown on the drawings.

## 7.3 EXCAVATION FOR OBSTRUCTIONS

- A. Should any obstruction be encountered during RAP/RI installation, the General Contractor shall be responsible for promptly removing such obstruction or the element shall be relocated if possible. Obstructions include, but are not limited to, boulders, timbers, concrete, granite blocks, utilities, etc., which shall prevent placing the elements to the required depth, or shall cause the RAP/RI element to drift from the required location.
- B. Dense natural rock or weathered rock layers shall not be deemed obstructions, and RAP elements may be terminated short of design lengths on such materials.

## 7.4 UTILITY EXCAVATIONS

The General Contractor shall coordinate all excavations made subsequent to RAP/RI installations so that excavations do not encroach on the elements as shown in the RAP construction drawings. Protection of completed RAP/RI elements is the responsibility of the General Contractor. In the event that excavations are required in close proximity to the installed RAP/RI elements, the General Contractor shall contact the Designer immediately to develop construction solutions to minimize impacts on the installed RAP elements.

## 7.5 FOOTING AND SLAB SUBGRADE PREPARATION

- A. Excavation and subgrade preparation of all footing and slab subgrades shall be the responsibility of the General Contractor and performed in conformance with the Project Specifications and RAP/RI design submittal.
- B. Excavations will expose the tops of RAP/RI elements and shall be made in a workman-like manner that protects the subgrade until structural fill or concrete placement. Procedures and equipment shall be selected to avoid subgrade/RAP/RI element disturbance and exposure to water.

- C. All excavations for footing bottoms supported by RAP/RI elements shall be prepared in the following manner by the General Contractor. Recommended procedures for achieving these goals are to:
1. Limit over-excavation below the bottom of the footing to 3-inches (including disturbance from the teeth of the excavation equipment).
  2. Compaction of surface soil and top of RAP/RI elements shall be prepared using a motorized impact compactor ("Wacker Packer," "Jumping Jack," or similar). Sled-type tamping devices shall only be used in granular soils and when approved by the Designer. Loose or soft surficial soil over the entire footing bottom shall be recompacted or removed, respectively. The surface of the RAP/RI elements shall be recompacted prior to completing footing bottom preparation.
  3. Place footing concrete immediately after footing excavation is made and approved, preferably the same day as the excavation. Footing concrete must be placed on the same day if the footing is bearing on moisture-sensitive soils. If same day placement of footing concrete is not possible, open excavations shall be protected from surface water accumulation. A lean concrete mud-mat may be used to accomplish this. Other methods must be pre-approved by the Designer.
- D. The following criteria shall apply, and a written inspection report sealed by the RI/RAP Designer shall be furnished to the Installer to confirm:
1. That water has not been allowed to pond in the footing excavation at any time. Ponded water may soften the unconfined matrix soil between and around the RAP elements, and may have detrimental effects on the supporting capability of the RAP reinforced subgrade.
  2. That all RAP elements designed for each footing have been exposed in the footing excavation.
  3. That immediately before footing construction, the tops of RAP elements exposed in each footing excavation have been inspected and recompacted as necessary with mechanical compaction equipment.
  4. That no excavations or drilled shafts (elevator, etc) have been made after installation of RAP elements within the excavation limits described in the RAP construction drawings, without the written approval of the Installer or Designer.
- E. Designer shall provide the above inspection and certification necessary to satisfy the written or implied warranty on the performance of the RAP/RI system.

## **PART 8 – PAYMENT**

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8.1 Method of Measurement

- A. Payment shall cover design, one mobilization, one modulus test on each type of ground improvement element used, preparation of ground improvement plans and specifications, installation of RAP/RI elements, quality assurance, demobilization, and quality assurance of Load Transfer Platform/footing pad/slab pad. Excavation of unsuitable materials and obstructions by others, delays, re-engineering, added modulus tests, added RAP elements, and added mobilization/demobilization as documented by the Owner's Representative and approved by the Owner or General Contractor, shall be paid for under separate pay items.

8.2 Basis of Payment

- A. Payment will be made as follows:

<u>Pay Item:</u>	<u>Pay Unit:</u>
One mobilization, one modulus test for RAP, one modulus Test for RI, preparation of RAP/RI design, plans and specifications, installation of RAP/RI elements, quality assurance and demobilization	\$____ Lump Sum
Additional ungrouted RAP elements due to obstructions or Owner design changes	\$____ / Linear Foot Installed
Additional RI elements due to obstructions or Owner design changes	\$____ / Linear Foot Installed
Additional modulus tests	\$____ Each
Additional mobilizations/demobilizations	\$____ Each
Quality assurance of Load Transfer Platform/ Footing Pad/Slab Pad	\$____ Lump Sum

- B. Unit prices for certain types of earthwork are included in section 012200 - UNIT PRICES. Bid form is included in section 005422 – BID ATTACHMENT UNIT PRICES SCHEDULE.

End of Section

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Section 32 00 00  
LANDSCAPE IMPROVEMENTS

**PART 1 - GENERAL**

1.1 GENERAL REQUIREMENTS

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.
- B. All references to products by manufacturer, trade name or performance Specifications bearing the connotation "or Approved Equal" shall be as determined by the Landscape Architect and the City, per MGL c. 30 s. 39M, part b, criteria 1.

1.2 WORK INCLUDED

- A. Provide all labor, equipment, implements and materials required to furnish, install, construct and perform all site improvements complete as shown on the Drawings and specified herein.
- B. To be included, but not limited to the following:
  - 1. Bollards;
  - 2. Bike Racks;
  - 3. Basketball Hoops and Poles;
  - 4. Stonedust Paving;
  - 5. Steel Edging;
  - 6. Peastone Drip Edge;
  - 7. Wooden Guard Rail.

1.3 REFERENCES

- A. Examine all other Sections of the Specifications and all Drawings for the relationship of the work under this Section and the work of other trades. Cooperate with all trades and all departments of the City and coordinate all work under this Section therewith.
- B. The following related items are included under the Sections listed below:
  - 1. Section 03 30 01 – Landscape Cast In Place Concrete
  - 2. Section 05 50 00 – Metal Fabrications
  - 3. Section 31 20 00 – Earthwork
  - 4. Section 31 25 00 – Erosion and Sedimentation Controls
  - 5. Section 32 10 00 – Bases, Ballasts, Paving, and Edging



#### 1.4 SUBMITTALS AND SHOP DRAWINGS

- A. Electronically submit shop drawings, product literature, catalog cuts and / or samples for all items indicating material characteristics, fabrications, details of construction, connections and relationship with adjacent construction, called for on the Drawings and as specified and in accordance with applicable requirements under Division 1. If not submitting above materials electronically, submit five complete copies.
  - 1. Bollards;
  - 2. Bike Racks;
  - 3. Basketball Hoop & Pole;
  - 4. Stonedust Paving;
  - 5. Steel Edging;
  - 6. Peastone Drip Edge;
  - 7. Wooden Guard Rail.
- B. Take field measurements prior to preparation or shop drawings and fabrication. Allow sufficient time for shop drawing review and approval, before fabricating or ordering.
- C. Do not order materials or begin installation of Work of this Section until Owner's / Landscape Architect's approval of submittals has been obtained. Delivered materials shall closely match approved samples.

#### 1.5 SAMPLES

- A. Initial Selection Samples: Submit samples showing complete range of colors, textures and finishes available for each material used.
- B. Verification Samples: Submit representative samples of each material that is to be exposed in the finished work, showing the full range of color and finish variation expected.

#### 1.6 PRODUCT LITERATURE

- A. For each product or material used, submit manufacturer's product data, including installation instructions, use, limitations and recommendations.

#### 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original unopened and undamaged packages and containers with labels legible and intact.
- B. Store and handle materials in accordance with manufacturer's instructions. Prevent damage and deterioration of products from the environment and construction operations.
- C. Handle in accordance with manufacturer's instructions.

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1.8 JOB CONDITIONS

- A. Examine all surfaces to receive site improvements to see that they are in proper condition to receive the Work specified. Report to the Landscape Architect in writing all unacceptable areas. All defects resulting from use of accepted surfaces shall be corrected by the appropriate Contractor at no additional expense to the Owner.
- B. Start of Work under this Section shall constitute acceptance of the site conditions to which this Work is to be applied. Site preparation shall be of proper approved quality. Any defects in Work resulting from such conditions shall be corrected under this Section, at no extra cost to the Owner.
- C. Environmental Requirements: Contractor shall not Work on or with soils when they are dry, wet, or frozen. Field Test: Form soil in palm of hand; if soil retains shape and crumbles upon touching, then it may be worked; (if it will not retain its shape, it is too dry; if it does not crumble, it is too wet). Landscape Architect shall be final authority on condition of soil.

1.9 DEFINITIONS

- A. The following items are included herein and shall mean:
  - 1. A.A.S.H.T.O. - American Association of State Highway and Transportation Officials.
  - 2. S.S.H.B. - Standard Specifications for Highway and Bridges, the Commonwealth of Massachusetts, Department of Public Works, latest edition.
  - 3. A.S.T.M. - American Society for Testing and Materials.
  - 4. CPSC - Consumer Product Safety Council.
  - 5. ADA - Americans with Disabilities Act and its current regulations.
  - 6. AWS: American Welding Society.
  - 7. SSPS: Steel Structures Painting Council.

1.10 WARRANTIES

- A. Attention is directed to provisions of the CONDITIONS OF THE CONTRACT and applicable parts of Division 1 regarding guaranties and warranties.
- B. Manufacturers shall provide their standard guaranties for Work specified in the Section. However, such guaranties shall be in addition to and not in lieu of all other liabilities which manufacturers and Contractor may have by law or by other provisions of the Contract Documents.

1.11 QUALITY ASSURANCE

- A. Comply with applicable codes, ordinances and regulations. Provide products of acceptable manufacturer, which have been in satisfactory, similar service for three years. Use experienced installers.

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## PART 2 - PRODUCT

### 2.1 BOLLARDS

#### A. Product

1. Bollards are to be Sentinel Bollards as Manufactured by Landscape Forms Inc. of Kalamazoo, Michigan. Ph: 800-521-2546. Web: [www.landscapeforms.com](http://www.landscapeforms.com), or Approved Equal.
2. Bollard is to be approx. 11.2" wide and 37.8" high with a Mitre top. Embedded mount.

#### B. Materials

1. Bollard Tube: ASTM A500 Grade B structural steel tube, 6" nominal pipe size (6.625" outside diameter x 0.280" wall).
2. Pole Mount Ring: 0.375" thick steel plate with 3/8"-16 threaded through holes. Ring is welded to top of bollard tube.
3. Bollard Sleeve: Cast aluminum, 319 or A413, 0.313" wall nominal.
4. Draw Ring: 0.250" thick steel plate ring.
5. Top Casting: Cast aluminum, 319, minimum thickness 0.215"
6. O-Ring: 0.188" diameter EPDM foam rubber gasket.
7. Top Mount Bracket: 7ga HRPO formed steel, magni-coated.
8. Fasteners
  - a. Mounting bolts (4) 3/8-16 x 3" hex head, magni-coated.
  - b. Lens mount screws (2) 8-32 x 1.5" Button Head Hex with pin, stainless steel.
  - c. U-clips (2), 8-32, magni-coated steel.
  - d. Removable bollard adjusting screws: 3/8-16 x 1" hex head cap screw, thin nut, and round base weld nut, all stainless steel.
9. Recycled Content
  - a. Post-Consumer: Min. 41 pct
  - b. Pre-Consumer: Min 26 pct
  - c. 100 pct recyclable
10. Finishes: Finish on Metal, Except Removable Bollard Socket: Landscape Forms, Inc. "Pangard II" or Approved Equal.
  - a. Primer: Rust inhibitor.
  - b. Topcoat: Thermosetting TGIC polyester powder coat. UV, chip, and flake resistant.
  - c. UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
11. Color: to be selected by Architect and Landscape Architect from full range of Manufacturer's Colors.

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## 2.2 BIKE RACKS

- A. Bicycle Racks shall be the BWRS-101 Cycle Sentry by Victor Stanley Inc., or Approved Equal.
- B. Materials
  - 1. 2-3/8" O.D. Tubular Steel tube
  - 2. 5" diameter surface mount flange.
- C. Finish:
  - 1. Powdercoat finish.
    - a. All fabricated metal components are to be steel shotblasted, etched, phosphatized, preheated, and electrostatically powder-coated with TGIC polyester powder coatings.
    - b. Products are to be fully cleaned and pretreated, preheated, and coated while hot to fill crevices and build coating film.
    - c. Coated parts are fully cured to coating manufacturer's specifications.
    - d. The thickness of the resulting finish averages 8-10 mils.
    - e. Color to be chosen by Landscape Architect, and Architect from manufacturer's full line of color options.
- D. Submit Manufacturer's Shop Drawings and color palette for color & finish selection.

## 2.3 BASKETBALL HOOP & POLE

- A. Backboard, goal, and net shall be manufactured by True Bounce, Inc. 194 Riverside Avenue, New Bedford MA 02746 (866-873-3715), or Approved Equal.
- B. Backboard shall be constructed with 1/2" thick, clear poly-carbonate, contain 1/2" perforated holes, and measure 72" x 42" (Rectangular). Backboard shall be framed with "E"-channeled extruded aluminum and attached with stainless steel hardware. Official sized white target shall be silk-screened on the face of the backboard. Goal mounting holes (4) to be standard 5" (horizontal) by 4" (vertical) mounting centers.
- C. Goal shall be Model # RB3000 front mount 18" single ring goal (5/8"), nylon net, powder coated finish or Approved Equal.
- D. Pole shall be a Gooseneck Pole system, 5 1/2" O.D. Schedule 40 steel pipe, with 6- layer galvanized finish.
- E. Contractor shall touch up any scratches or other marks to surfaces and finishes after installation with products as approved by the manufacturer.

## 2.4 STONEDUST PAVING

- A. Stone
  - 1. Stone for paving to be decomposed granite 3/8" or 1/4" crushed aggregate screenings. Sand and crushed stone shall consist of inert

materials that are hard and durable, with stone free from surface coatings and deleterious materials. Gradation requirements shall be as follows: Crushed Stone Sieve Analysis Percentage of Weight Passing a Square Mesh Sieve AASHTO T11-82 and T2782.

1/4" MINUS AGGREGATE GRADATION

US Sieve No.	Percent Passing by Weight
#3/8"	100
#4	90-100
#8	75-80
#16	55-65
#30	40-50
#50	25-35
#100	15-20
#200	10-15

2. Color to be determined by Landscape Architect. Submit sample(s) as requested.
3. Stabilizer Binder
  - a. Binder to be: Stabilizer® for Stabilized Aggregate surfaces (as provided by Stabilizer Solutions, Inc. 33 South 28th St., Phoenix, AZ 85034; phone 602 225-5900, and distributed locally by Read Custom Soils, 158 Tihonet Road, Wareham, MA 02571, phone 781.828.6300), or Approved Equal.
  - b. Binder shall be a non-toxic, organic, colorless and odorless concentrated powder that binds decomposed granite or crushed 3/8" or 1/4" minus aggregate. Product to have 64% pre-consumer recycled content. Producer shall have 25 years experience at same formulation.

2.5 STEEL EDGING

- A. Steel edging shall be a commercial grade steel edging, 1/4" x 5", fabricated in 10' or 16' sections with anchor stake loops stamped in face of section 32" on center. "Border King" by Landscape Concepts, or Approved Equal.
- B. Use 18" or 24" (as noted on Drawings) tapered steel anchoring stakes (3/16" thick) provided by manufacturer. 24" long stakes need to be ordered specifically.
- C. Edging and stakes shall be finished with enamel paint (black).

2.6 PEASTONE DRIP EDGE

- A. Peastone shall be 3/8" nom. rounded stone.
- B. Color to be brown/tan. Sample to be approved by Landscape Architect prior to installation.
- C. Steel edging to be as per 2.5 above, set flush with grade.

2.7 WOODEN GUARD RAIL

- A. Wooden guardrail to be as shown and detailed in the drawings.
- B. All lumber is to be pressure treated.
- C. Contractor to submit shop drawings for approval.
- D. Finish is to be determined by Architect and Landscape Architect.

**PART 3 - EXECUTION**

3.1 BOLLARDS

- A. Install as shown in Drawings. Contractor to touch up any scratches and all mars to surfaces or finishes.

3.2 BIKE RACKS

- A. Install as shown in Drawings and per Manufacturer's instructions. Contractor to touch up any scratches and all mars to surfaces or finishes.

3.3 BASKETBALL POSTS, BACKBOARDS, RIMS, AND NETS

- A. To be installed per drawings and per manufacturer's specifications, with appropriate clearances, and in accordance with standard practices for Basketball Court construction and City of Framingham standards.

3.4 STABILIZED STONE DUST

- A. Preparation:
  - 1. Base shall be 6" dense graded gravel.
  - 2. Pre-soak base material with water and compact to 95% determined by test method ASTM D 1557 prior to installing Stabilized Aggregate. Compaction testing to be provided by contractor, one test per 2,000 square feet.
- B. Blending Stabilizer
  - 1. Stabilizer shall be thoroughly pre-mixed with aggregate at the rate of 15 lbs of Stabilizer per 1 ton of aggregate. Verify with manufacturer correct Stabilizer rate for your project and climate. Drop spreading of Stabilizer over pre-placed aggregate or mixing by rototilling is not acceptable. Stabilizer shall be mechanically pre-mixed per manufacturer's recommendations using an approved mechanical blending unit to adequately blend Stabilizer with aggregate (Bucket blending is not an approved blending apparatus). Always blend Stabilizer and aggregate DRY.
- C. Placement
  - 1. After pre-blending, place stabilized aggregate directly on prepared sub-grade. Level to desired grade and cross section. Depth of pathways shall

be 3" for heavy foot traffic and light vehicles. DO NOT place on filter fabric. Contact Supplier. for installation on slopes greater than 8%.

D. Watering

1. Water heavily for full-depth moisture penetration of profile. Water activates Stabilizer. Apply 25 to 45-gallons of water per 1-ton to achieve saturation. Randomly test for depth using a probing device, which reaches full depth.
2. Contractor shall wait a minimum of 6 – 72 hours or until such time that the Stabilized Aggregate is able to accept compaction from a 1 to 5 ton roller without separation.
3. If surface aggregate dries significantly quicker than subsurface material, lightly mist surface before compaction.

E. Compaction

1. Compact Stabilized Aggregate to 85% relative compaction by equipment such as; a 2 to 5-ton double drum roller making 3 to 4 passes. Do not begin compaction for 6 hours after placement and up to 72 hours. DO NOT use a vibratory plate compactor or vibration feature on roller, as vibration separates large aggregate particles. If pumping or pancaking of surface occurs, surface is still too wet to roll.
2. Take care in compacting surface when adjacent to planting and irrigation systems, use 8" or 10" hand tamp. Installation of Stabilized Aggregate more than 3" thick shall be installed in lifts. If 4" thick compacted (2) 2" lifts. If 5" thick compacted (2) 2.5" lifts. If Stabilized Aggregate is pre-moistened before installation entire 4" or 5" lift may be installed.
3. Lightly spray surface area following compaction. Do not disturb aggregate surface with spray action.

F. Inspection

1. Finished surface shall be smooth, uniform and solid with no evidence of chipping or cracking. Cured and compacted pathway shall be firm throughout profile with no spongy areas. Loose material shall not be present on surface after installation, but may appear after use and according to environmental conditions. Pathway shall remain stable underneath loose granite on top with a "natural" look. Any significant irregularities in path surface shall be repaired to the uniformity of entire installation.

G. Protection

1. Contractor shall furnish and install construction fence around new surface to prevent public access. Fencing shall be maintained in place for a minimum of 12 - 72 hours after completion of installation, or as directed by the Owner' Representative. Drying period may take longer due to weather conditions.
2. Contractor shall notify Owner's Representative that landscape irrigation shall be restricted near Stabilized Aggregate surface until drying period is

complete. Standing water on surface and adjacent to path shall be restricted at all times.

H. Maintenance

1. Remove debris, such as paper, grass clippings, or organic material by mechanically blowing or hand raking as needed. When plowing snow, use rubber baffle on plow blade or wheels on plow to lift blade 1/4" off the surface.
2. During first year, minor amounts of loose aggregate may appear on surface (1/16 to 1/4"). If material exceeds a 1/4", redistribute over entire surface. Water to 1" depth and compact with power roller of no less than 1000-lbs. Repeat as needed. If cracking occurs, sweep fines into cracks, water thoroughly and hand tamp with an 8" – 10" hand tamp.

I. Repairs

1. Excavate damaged area to the depth of the Stabilized Aggregate and square off sidewalls.
2. If area is dry, moisten damaged portion lightly.
3. Pre-blend the dry required amount of Stabilizer with the proper amount of aggregate in a concrete mixer.
4. Add water to the pre-blended Stabilized Aggregate. Thoroughly moisten mix with 25 to 45 gallons per 1-ton of pre-blended material or to approximately 10% moisture content.
5. Apply moistened pre-blended Stabilized Aggregate to excavated area to finish grade.
6. Compact with an 8" to 10" hand tamp or 250 to 300 pound roller. Keep traffic off areas for 12 to 48 hours after repair has been completed.

3.5 STEEL EDGING

- A. Install steel edging straight and true and according to manufacturer's instructions.
- B. Ensure that all stakes are firmly seated.
- C. Ease all field-cut edges to avoid sharp corners and laceration hazards; all cut ends shall be sealed with a rust-inhibiting primer and painted to match adjacent finish.

3.6 PEASTONE DRIP EDGE

- A. Install Peastone as shown on the drawings and tamp evenly into place.
- B. Steel edge to be installed according to manufacturer's instructions. Ensure all lines are straight and true.

3.7 WOODEN GUARD RAIL

- A. Install as shown in Drawings.



3.8 CLEANING

- A. Waste disposal: Comply with all regulations regarding handling, storage, and disposal of all hazardous materials and waste. Consult local agencies or disposal companies for individual instructions and requirements. Improper disposal of paint and their related materials is illegal and may result in large fines. Please comply with all regulations and minimize waste whenever possible.
- B. Perform cleaning during installation and upon completion of paving work. Remove from site all excess materials, debris, and equipment.

3.9 STANDARDS AND COMPLETION

- A. Upon completion, the contractor(s) shall remove and properly dispose of all construction debris, surplus materials, and empty containers, and leave the site in a condition acceptable to the Owner.

END OF SECTION

SECTION 32 12 16  
ASPHALT PAVING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
  - 1. Hot-mix asphalt paving, including walkways, ramps and curbs.
  - 2. Hot-mix asphalt patching.
  - 3. Pavement-marking paint.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
  - 1. Section 310000 - EARTH MOVING for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
  - 1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- C. Material Certificates: For each paving material, from manufacturer.

#### 1.4 QUALITY ASSURANCE

- A. **Manufacturer Qualifications:** A paving-mix manufacturer registered with and approved by the Massachusetts Highway Department (MHD).
- B. **Regulatory Requirements:** Comply with materials, workmanship, and other applicable requirements of the Massachusetts Highway Department (MHD) for hot mix asphalt paving work.
  - 1. Comply with requirements of the Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, including supplemental specifications and special provisions.
  - 2. Comply with requirements of the Americans with Disabilities Act (ADA) and the Massachusetts Architectural Access Board (MAAB). If these requirements cannot be met with the grades and slopes indicated on the plans, notify the Designer immediately.
  - 3. Comply with requirements of the local authority having jurisdiction concerning the location and construction of accessible curb cuts.
- C. **Preinstallation Conference:** Conduct conference at Project site to comply with requirements in Division 01.
  - 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
    - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
    - b. Review condition of subgrade and preparatory work.
    - c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
    - d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

## 1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
  - 1. Tack Coat: Minimum surface temperature of 60 deg F.
  - 2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
  - 3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
- C. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

## PART 2 - PRODUCTS

### 2.1 AGGREGATES

- A. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- B. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
- C. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.
- D. Reclaimed Asphalt Pavement (RAP): Provide material obtained from the highways or streets by crushing, milling, or planing existing hot mix asphalt pavements.
  - 1. The proportion of RAP to virgin aggregate for base course mixtures and intermediate course mixtures shall be limited to a maximum of 40% for drum mix plants and 20% for modified batch plants. The maximum amount of RAP for surface course mixtures shall be 10%.

### 2.2 ASPHALT MATERIALS

- A. Asphalt Binder, Performance Graded: AASHTO M320 or AASHTO MP 1a, performance grade as required by MHD Specifications.
- B. Tack Coat: AASHTO M 140 emulsified asphalt, or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

### 2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Pavement-Marking Paint: Acrylic/latex type, low VOC, traffic marking paint.
  - 1. Color: As indicated.
- C. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
  - 1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

### 2.4 ASPHALT MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by MHD Specifications and designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types".

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

### 3.2 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

### 3.3 PATCHING

- A. Existing Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

- B. Existing Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
  - 1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a minimum rate of 0.05 to 0.15 gal./sq. yd..
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

### 3.4 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

### 3.5 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  - 1. Spread mix at minimum temperature of 250 deg F.
  - 2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### 3.6 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
  - 1. Clean contact surfaces and apply tack coat to joints.
  - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
  - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
  - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

### 3.7 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
  - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
  - 1. Average Density: ASTM D 2041, per MHD Specifications.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

### 3.8 ASPHALT CURBS

- A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F.
  - 1. Asphalt Mix: Same as pavement surface-course mix.
- B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

### 3.9 INSTALLATION TOLERANCES

- A. Accessibility: Comply with requirements of Massachusetts Architectural Access Board and ADAAG requirements. Remove and replace paving that does not meet required tolerances, when measured with a 2 foot straightedge.
- B. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  - 1. Base Course: Plus or minus 1/2 inch.
  - 2. Surface Course: Plus 1/4 inch, no minus.
- C. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within MHD Specification tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas.

### 3.10 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Designer.
- B. Allow paving to age for a minimum of 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

### 3.11 WHEEL STOPS

- A. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.



3.12 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Cooperate with the Independent Testing Agency engaged by City of Framingham for field quality control activities for the Work of this Section. Refer also to Section 014325 - TESTING AGENCY SERVICES.
- B. Test the plane of the finished surfaces of base, binder, and surface courses with a 16-foot straightedge, except use a 10-foot straightedge on vertical courses and on the top course of resurfaced streets which contain manhole covers, valve boxes, and the like.
- C. Carefully apply the straightedge immediately after the first compaction by rolling, and from then on as may be necessary until and after the final compaction of the material in place. Hold the straightedge in successive positions parallel to the road centerline and in contact with the road surface; check the entire area from one side of the pavement to the other.
- D. Correct irregularities which vary  $\frac{3}{8}$  inch from a true finished surface in base and binder courses, and  $\frac{1}{4}$  inch in top courses.
- E. Irregularities which may develop before the completion of rolling and while the material is still workable, may be remedied by loosening the surface mixture and removing or adding material as necessary. Should any unsatisfactory irregularities or defects remain after final compaction, correct the defective work by removing and replacing with new material to form a true and even surface.

3.13 OPENING TO TRAFFIC

- A. No vehicular traffic or loads shall be permitted on the newly completed pavement until adequate stability has been attained, and the material has cooled sufficiently to prevent distortion or loss of fines, and the pavement has achieved a maximum temperature of 140 degrees F.
- B. If the climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the Architect.

3.14 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION

SECTION 32 16 14

PRECAST CONCRETE CURBS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Earthwork: Section 31 00 00.

1.02 SUBMITTALS

- A. Product Data: Catalog sheets, specifications, and installation instructions for precast curbs.
- B. Quality Control Submittals:
  - 1. Test Reports: Random freeze thaw tests shall be conducted by the manufacturer. Test specimens shall retain 60 percent of its initial modulus of elasticity after 300 cycles. Test results shall be made available to the Director upon request.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Provide precast concrete curbs with a minimum compression strength of 5000 pounds per square inch. Castings shall have plane smooth surfaces, true to line and face, free from defects, sharp arises, and with curved surfaces accurately reproduced. Overall dimensions for each casting shall not vary more than 1/16 inch from those indicated.
- B. Curb units shall be cast at the manufacturers plant. Job site castings will not be permitted.
- C. Curbing to be set on a radius of 100 feet or less shall be cast to the curve required. Ends shall be formed or sawed on radial lines.
- D. Curb Foundation: One part Portland cement to six parts No. 1A coarse aggregate dry mix.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Set curb true to line and grade on a foundation of one cubic foot of dry concrete for each linear foot of curb installed. Ram all spaces under the curb so that it is completely supported throughout the entire length.

- B. Butt joint curb sections together.
- C. Install joint sealer where curb abuts existing walls, posts, buildings, and fixed structures or appurtenances.

3.02 RESETTING EXISTING CURBS

- A. Remove mortar and concrete from existing curbs to be reused. Replace units damaged by the contractor's negligence.
- B. Reset existing curbs approved for reuse by the City of Framingham.

3.03 FIELD QUALITY CONTROL

- A. The City of Framingham may conduct additional tests at their discretion. Replace curb units taken for testing, not to exceed 10 linear feet for each 1000 feet or fraction thereof delivered to the project.

END OF SECTION

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SECTION 32 16 40

GRANITE CURB

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 WORK INCLUDED

- A. The work includes furnishing all labor, materials, equipment, and supervision to construct the various types of granite curbing, in accordance with the Drawings and Specifications.

1.3 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
  - 1. Section 014000 - QUALITY REQUIREMENTS; Inspection and testing.
  - 2. Provision of waste management: Section 017419 - Construction Recycling Waste Management Plan.
  - 3. Section 033000 - CAST-IN-PLACE CONCRETE; Concrete curb; concrete for base.
  - 4. Section 310000 - EARTH MOVING; Establishment of subgrade elevations and courses.
  - 5. Section 321216 - ASPHALT PAVING.

1.4 REFERENCES

- A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
  - 1. American Society for Testing and Materials (ASTM):
    - a. ASTM C 131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
    - b. ASTM C 615 Structural Granite
  - 2. Commonwealth of Massachusetts Highway Department (MHD): Specifications Standard Specifications for Highway and Bridges

1.5 SUBMITTALS

- A. Submit complete shop drawings of each curb type and size for Architect's approval.

1.6 SAMPLE SECTION

- A. A sample curb section, full dimension, 6 feet long minimum, shall be fabricated prior to start of granite curbing. The work will be inspected by the Architect. If the original sample is not acceptable, the Contractor shall construct additional sample sections until an accepted sample is obtained. The accepted sections shall become the standard for the entire job, and shall remain undisturbed until completion of all granite curbing.

1.7 QUALITY ASSURANCE

- A. Unless otherwise indicated, granite curb materials and construction shall conform to the applicable portions of the following:
  - 1. MHD Specifications Section 500, "Curb and Edging."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Granite curb units shall be delivered to the job adequately protected from damage during transit.
- B. Curb shall be protected against staining, chipping, and other damage. Cracked, badly chipped, or stained units will be rejected and shall not be employed in the work.

PART 2 - PRODUCTS

2.1 BASE COURSE

- A. Material for base course shall be Dense Graded Crushed Stone, as specified in Section 310000 - EARTH MOVING.

2.2 GRANITE CURB

- A. Granite curb required to complete the work of this Section shall be a structural granite conforming to ASTM C 615, Class I Engineering Grade, suitable for curbstone use.
  - 1. Curb shall be light grey, free from seams which impair structural integrity, and with percentage of wear less than 32%, as determined by ASTM C 131.
- B. Curb materials shall conform to MHD Specifications Section M9.04.0 and shall meet requirements specified in the subsection of Division III, Materials of the MHD Specifications:
  - 1. Item:

- a. Vertical Granite Curb.
  - b. Transitional Granite Curb.
  - c. Flush Granite Curb.
- C. Provide sawn vertical faces on both sides for all curb sizes. Provide thermal finish on exposed pavement/paver side only.

## 2.3 CEMENT MORTAR

- A. Mortar for pointing joints between curbstones shall be a cement mortar composed of one-part Portland cement and two parts sand, by volume with sufficient water to form a workable, stiff mixture.

## 2.4 CONCRETE

- A. Concrete for foundation at joints shall conform to Section 033000 - CAST-IN-PLACE CONCRETE.

## PART 3 - EXECUTION

### 3.1 GRADING

- A. Areas to receive granite curb will be compacted and brought approximately to subgrade elevation under Section 310000 - EARTH MOVING before work of this section is performed. Final fine grading, filling, and compaction of subgrade to receive curbing to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, shall be done under this Section.
- B. Existing subgrade material which will not readily compact shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be material conforming to Section 310000 - EARTH MOVING.
- C. Subgrade of areas to receive curbing shall be recompacted to bring top 8 inch of material immediately below gravel base course to a compaction of at least 90% of maximum density, as determined by ASTM D 1557, Method D. Subgrade compaction shall extend for a distance of at least 1 ft. beyond curb edge.
- D. Excavation required in subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade or subbase subsequent backfill and compaction shall be performed as specified in Section 310000 - EARTH MOVING. Completed subgrade after filling such areas shall be uniformly and properly graded.
- E. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 inch deep in subgrade, shall be graded out, reshaped and recompacted before placing granite curb.
- F. Materials shall not be stored or stockpiled on subgrade.

- G. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this Section shall be legally disposed of off-site.
- H. Prepared subgrade will be inspected by the Architect. Subgrade shall be approved by the Architect before installation of aggregate base course. Disturbance to subgrade caused by inspection procedures shall be repaired under this Section of the specification.

### 3.2 AGGREGATE BASE COURSE

- A. Aggregate base course for paving and the spreading, grading, and compaction methods employed shall conform to Section 310000 - EARTH MOVING.
- B. Subgrade and base course shall be kept clean and uncontaminated. Less select materials shall not be permitted to become mixed with gravel. Materials spilled outside pavement lines shall be removed and area repaired.
- C. Portions of subgrade or of construction above which become contaminated, softened, or dislodged by passing of traffic, or otherwise damaged, shall be cleaned, replaced, and otherwise repaired to conform to the requirements of Section 310000 - EARTH MOVING before proceeding with next operation.

### 3.3 SETTING CURB

- A. Curb shall be set in aggregate base with continuous concrete haunch foundation, with trench bottom at minimum 6 inch below bottom of curb. Excavation shall be filled to required level with base course material as specified above.
- B. Vertical face of vertical curb shall be plumb, with curb top parallel to adjacent surface.
- C. Curb shall be set accurately to line and grade in continuous haunch. Curb units shall be fitted together as closely as possible. Curb shall not be field cut.
- D. Joints, between curb units shall be carefully filled with a cement mortar, and neatly pointed on the top and front exposed portions. After pointing, excess mortar shall be cleaned from curb surface.
- E. Backfill material on each side of curb shall be as specified for adjacent surface and shall be thoroughly compacted by means of power tampers. Extreme care shall be taken not to destroy alignment. Curb sections disturbed during backfilling or otherwise shall be reset to line and grade, and properly backfilled.

END OF SECTION

SECTION 32 17 23  
PAVEMENT MARKING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

- A. Provide all equipment and materials, and do all work necessary for pavement marking, including crosswalks and lines, handicap striping, and parking lot striping, as indicated on the Drawings and as specified.

1.03 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
  - 1. Section 014500, QUALITY REQUIREMENTS; Inspection and testing.
  - 2. Section 321216, ASPHALT PAVING; Asphaltic concrete paving, including asphaltic concrete base for concrete pavers.

1.04 REFERENCES

- A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
  - 1. Federal Specifications (Fed. Spec.):  
TT-P-115E Paint, Traffic, Highway, White, and Yellow
  - 2. Commonwealth of Massachusetts Highway Department (MHD):  
Specifications Standard Specifications for Highways and Bridges.
  - 3. Rules and Specification, For Excavation Activity Within the City of Boston, City of Boston Public Works Department.

1.05 LAYOUT OF WORK

- A. The Contractor shall furnish to the Architect for approval a schedule of pavement marking operations in accordance with MHD Specifications Section 860.



1.06 SUBMITTALS

- A. Lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation.

1.07 DELIVERY AND STORAGE

- A. All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

1.08 EQUIPMENT

- A. All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Equipment operating on roads and runways shall display low speed traffic markings and traffic warning lights.

1.09 TRAFFIC CONTROL

- A. Traffic Controls: NOTE: Guidance for traffic control procedures can be obtained from the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways.
- B. Place traffic cones along newly painted lines to control traffic and prevent damage to newly painted surfaces. Remove when paint has dried fully.

1.10 WEATHER LIMITATIONS

- A. Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for water blasting and removal of previously applied chemicals. Water blasting shall cease where surface water accumulation alters the effectiveness of material removal.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Pavement Markings shall conform to the BTD's Rules and Specifications. All thermoplastic pavement markings furnished and applied by shall be in accordance with the Massachusetts Department of Public Works Specifications dated 1988, sections 860 and M7, sub section X7.01. 20 or latest revisions thereof. The raw materials used must be thoroughly melted, blended and mixed in the manufacturing process before delivery.
- B. Paint and reflective media shall be in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of

manufacture, manufacturer's name, formulation number and directions, all of which shall be plainly legible at time of use.

2.03 PAINT MATERIAL

- A. The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months, color as indicated. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

2.06 APPLICATION EQUIPMENT

A. Application Equipment for Marking Materials

- 1. Application equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment which come into contact with the material shall be easily accessible and exposable for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns shall maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.
- 2. The application equipment shall be constructed to ensure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying "skip lines". The equipment shall be capable of applying varying widths of traffic markings.

B. Mobile and Maneuverable: Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed, and normal curves can be made in a true arc. The equipment used for the placement of pavement markings shall be of two general types:

- 1. Mobile Application Equipment: The mobile applicator shall be defined as a truck mounted, self-contained pavement marking machine that is capable of applying paint markings. The unit shall be equipped to apply the marking material at widths varying from 3 to 12 inches, and in varying thicknesses. The mobile unit shall be capable of operating continuously and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.
  - a. The mobile unit shall be equipped with an electronic programmable line pattern control system. The control system shall be capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, the mobile unit shall be equipped with an automatic counting mechanism capable of recording the number of lineal feet of markings applied to the pavement surface with an accuracy of 0.5 percent.

2. Portable Application Equipment: The portable applicator shall be defined as hand operated equipment, specifically designed for placing special markings such as crosswalks, stop bars, legends, arrows, and short lengths of lane, edge and centerlines. The portable applicator shall be equipped with all the necessary components so as to be capable of extruding a line of 3 to 12 inches in width, and in varying thicknesses and of generally uniform cross section.

## 2.07 SURFACE PREPARATION EQUIPMENT

- A. Sandblasting Equipment: shall include an air compressor, hoses, and nozzles of proper size and capacity for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.
- B. Water blast Equipment: The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.
- C. Marking Removal Equipment: shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Water blasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.
- D. Shot blasting Equipment: shall be capable of producing an adjustable depth of removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.
- E. Chemical Equipment: shall be capable of application and removal of chemicals from the pavement surface and shall leave only non-toxic biodegradable residue.

## 2.08 REFLECTIVE MEDIA DISPENSER

- A. The dispenser for applying the reflective media shall be attached to the paint dispenser and shall operate automatically and simultaneously with the applicator through the same control mechanism. The dispenser shall be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION, at all operating speeds of the applicator to which it is attached.

## PART 3 - EXECUTION

### 3.01 SURFACE PREPARATION

- A. Surfaces to be marked shall be thoroughly cleaned before application of the pavement marking material. New pavement surfaces shall be allowed to cure for a period of not less than 48 hours before application of marking materials.

- B. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods. Rubber deposits, surface laitance and other coatings adhering to the pavement shall be completely removed.
- C. Where oil or grease are present on old pavements to be marked, affected areas shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be recleaned, when work has been stopped due to rain.

### 3.02 PRIMER

- A. After surface preparation has been completed the asphalt and/or concrete pavement surface shall be primed. The primer shall be applied with spray equipment. Primer materials shall be allowed to "set-up" prior to applying the final paint composition. The asphalt concrete primer shall be allowed to dry to a tack-free condition, usually occurring in less than 10 minutes. The Portland cement concrete primer shall be allowed to dry in accordance with the manufacturer's recommendations. To shorten the curing time of the epoxy resins an infrared heating device may be used on the concrete primer.

### 3.03 APPLICATION OF MARKING MATERIALS

- A. Marking materials shall be applied to clean, dry surfaces. Pavement marking materials shall be applied evenly to the pavement surface to be coated at a rate specified recommended by the paint manufacturer
- B. Paint: Paint shall be applied with approved equipment. Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied with approved equipment at rate of coverage specified. The Contractor shall provide guide lines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.
- C. Guidelines and templates shall be employed as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.
- D. Maximum drying time requirements of the paint manufacturer shall be enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by vehicle tires.
- E. If markings require more drying time than stated by the paint manufacturer, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

3.03 PROTECTION OF MARKINGS

- A. Markings shall remain protected until sufficiently dry to bear traffic.

END OF SECTION

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Section 32 90 00  
PLANTING

**PART 1 - GENERAL**

1.1 GENERAL REQUIREMENTS

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.
- B. All references to products by manufacturer, trade name or performance Specifications bearing the connotation "or Approved Equal" shall be as determined by the Landscape Architect and the City, per MGL c. 30 s. 39M, part b, criteria 1.
- C. Contractor shall comply with all laws, regulations, and quarantines for agricultural and horticultural products.

1.2 WORK INCLUDED

- A. The work of this Section consists of the provision of all materials, labor, equipment and the like for the complete execution of all lawn establishment by sodding and related items as indicated on the Drawings and/or as specified herein.
- B. Work includes but is not limited to the following:
  - 1. Topsoil (loam borrow), fine grading and loaming;
  - 2. Plant Materials;
  - 3. Soil additives;
  - 4. Mulch;
  - 5. Hydro-seeded Lawns, including athletic fields;
  - 6. Sod;
  - 7. Meadow Grass Seed Mix;
  - 8. Detention Basin Seed Mix;
  - 9. Erosion Control Fabric;
  - 10. Maintenance, watering, and protection of plantings until final acceptance.

1.3 SPECIAL CONDITIONS

- A. No burning will be permitted on the project site.
- B. Prior to commencing work, the Contractor shall submit a plan for legal disposal of removed materials, acceptable to the Owner.

1.4 REFERENCES

- A. Examine all other Sections of the Specifications and all Drawings for the

relationship of the work under this Section and the work of other trades. Cooperate with all other trades and all departments of the City and coordinate all work under this Section therewith.

- B. Related items include but are not limited to work under the Sections listed below:
1. Section 02 41 00 – Demolition and Site Preparation
  2. Section 31 00 00 – Earthwork

## 1.5 SUBMITTALS

- A. Prior to ordering the below listed materials, submit representative samples to Landscape Architect for selection and approval, in accordance with requirements of General Condition and special provisions as follows. Do not order material until Landscape Architect's approval has been obtained. Delivered materials shall closely match the approved samples.
1. Topsoil: The Contractor shall provide a one (1) cubic foot representative sample from each proposed source for testing and approval as directed by the Landscape Architect. The Contractor shall deliver samples to testing laboratory prior to any loaming and shall have the testing report sent directly to the Landscape Architect, and pay all costs.
    - a. Mechanical and chemical (pH soluble salts) analysis shall be by public extension service agency or a certified private testing laboratory in accordance with the current standards of the Association of Official Agricultural Chemists.
    - b. Report shall be submitted at least one (1) month before any loaming is to be done. Soil tests shall be for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Soluble Salts, and Lead, and show acidity and USDA classification of the soil.
  2. Submit a written guarantee of conformance to specifications for sod.
  3. Submit material specifications and installation instructions where applicable attesting that soil additives meet the requirements specified.

## 1.6 DEFINITIONS

- A. The following related items are included herein and shall mean:
1. S.S.H.B.: The Commonwealth of Massachusetts, Department of Public Works, Standard Specifications for Highways and Bridges, latest edition
  2. A.O.A.C.: Association of Official Agricultural Chemists
  3. A.A.N.: American Association of Nurserymen

## 1.7 PRODUCT DELIVERY AND HANDLING

- A. All topsoil, whether from stockpiles on site or loam borrow, shall be stored in piles not to exceed six feet in height, and shall not be handled when frozen or not in a friable condition.

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1.8 CERTIFICATION OF ACCEPTANCE AND GUARANTEE

- A. The Contractor shall be responsible for maintenance until the LATER of: the acceptance of the project as substantially complete, or 90 days after installation. After the minimum ninety (90) day maintenance period and substantial completion of the project, the Contractor shall request of the Landscape Architect, in writing, an inspection to determine whether the lawns and plantings are acceptable. If the plant material and workmanship are acceptable, written notice will be given by the Landscape Architect to the Contractor stating that the guarantee period begins from the date of the Certificate of Acceptance. Acceptance shall be given only for the entire lawn area covered by the Contract, and for all plantings.
- B. Lawns shall exhibit a uniform, thick, well-developed stand of grass, which has received a minimum of three cuttings. Lawn areas shall have no bare spots in excess of four inches in diameter, and bare spots shall comprise no more than two percent of the total area of the lawn. No lawn areas shall exhibit signs of damage from erosion, washouts, gullies, or other causes.
- C. Lawns, shrubs, and perennials shall be guaranteed for a period of one calendar year after inspection and acceptance and shall be alive and in satisfactory growth at the end of the guarantee period. Trees 3" caliper or greater shall be guaranteed for a period of two calendar years after inspection and acceptance.
- D. At the end of the guarantee period, inspection will be made again. Any lawn area or planting covered under this contract that is dead or unsatisfactory shall be replaced according to the planting seasons called for herein, until the lawn or planting lives through one guarantee period. A final inspection for acceptance will be made after the replacement plantings have lived through one guarantee period. Contractor shall test soil and add fertilizer and lime as needed in the fall after installation.
- E. All replacements shall be the same turf mix (sod), seed mix (meadow mix, detention basin mix, and seeded lawns, and sports fields) or species and cultivar (plantings) as originally installed and accepted. The cost shall be borne by the Contractor.

1.9 SITE CONDITIONS

- A. All areas to be planted shall be inspected by the Contractor before starting work and any defects such as incorrect grading, etc., shall be reported to the Landscape Architect prior to beginning this work. The commencement of work by the Contractor shall indicate his acceptance of the areas to be planted and he shall assume full responsibility.
- B. Environmental Requirements: Contractor shall not work on or with soils when they are dry, wet, or frozen. Field Test: Form soil in palm of hand; if soil retains shape and crumbles upon touching, then it may be worked (if it will not retain its shape, it is too dry; if it does not crumble, it is too wet). Landscape Architect shall be final authority on condition of soil.



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## 1.10 PROTECTION

- A. The Contractor shall be liable for any damage to property caused by the work, and all areas disturbed shall be returned to their original condition to the satisfaction of the Landscape Architect. During all work of this section, the Contractor shall protect all site improvements from contact with agricultural chemicals, soil amendments, and fertilizers.
- B. The Contractor shall provide all erosion, sedimentation, and environmental controls necessitated by site and governing codes.
- C. Damage no plant to remain by burning, by pumping of water, by cutting of live roots or branches, or by any other means. No plant to be saved shall be used for crane stays, guys, or their fastenings. Vehicles shall not be parked within the dripline of trees to remain, or wherever damage may result to trees to be saved. Construction material shall not be stored beneath trees to be saved. See Drawings for Tree Protection.

## PART 2 - PRODUCT

### 2.1 TOPSOIL/LOAM

- A. Loam shall be a "fine sandy loam" or a "sandy loam" determined by mechanical analysis and based on the USDA classification system. It shall be of uniform composition, without admixture of subsoil. It shall be free of stones greater than one inch, lumps, plants and their roots, debris and other extraneous matter over one inch in diameter or excess of smaller pieces of the same materials as determined by the Landscape Architect. It shall not contain toxic substances harmful to plant growth. Loam shall contain not less than 4% nor more than 10% organic matter as determined by the loss on ignition of oven-dried samples. Test samples shall be oven-dried to a constant weight at a temperature of 230 F, plus or minus 9.
- B. Loam shall have an acidity range of pH 5.6 to pH 6.5.
- C. The amount of either sulfur or limestone required to adjust the planting loam to the proper pH range (above) shall be determined by the Landscape Architect on the basis of soil tests as specified herein.
- D. Soil tests for this area shall be through the University of Massachusetts Amherst Cooperative Extension Soil Testing Laboratory, with recommendations for both Grasses/Lawns and Trees/Shrubs, or Approved Equal testing service (submit proposed alternative before testing).

### 2.2 PLANT MATERIALS

- A. The Contractor shall furnish and plant all plants shown on the Drawings, as specified, and in quantities listed on the Plant List. No substitutions will be permitted. All plants shall be nursery-grown unless specifically authorized to be collected.
- B. Plants shall be in accordance with the USA Standard for Nursery Stock of the American Association of Nurserymen, latest edition.

- C. All plants shall be typical of their species or variety and shall have a normal habit of growth and be legibly tagged with the proper name. Only plant stock grown within the hardiness Zones 1 through 6, as established by the United States Department of Agriculture, will be accepted. The Contractor's suppliers must certify in writing that the stock has actually been grown under Zone 6 or hardier conditions for a minimum of 2 years. Plants not so certified will not be accepted.
- D. The root system of each shall be well provided with fibrous roots. All parts shall be moist and show active green cambium when cut. They shall be sound, healthy, and vigorous, well-branched and densely foliated when in leaf. They shall be free of disease, insect pests, eggs or larvae.
- E. All plants must be moved with the root systems as solid units with balls of earth firmly wrapped with untreated eight (8) ounce burlap, firmly held in place by a stout cord or wire. The diameter and depth of the balls of earth must be sufficient to encompass the fibrous and root feeding system necessary for the healthy development of the plant. No plant shall be accepted when the ball of earth surrounding its roots has been badly cracked or broken preparatory to or during the process of planting or after the burlap, staves, ropes or platform required in connection with its transplanting have been removed. The plants and balls shall remain intact during all operations. All plants that cannot be planted at once must be heeled in by setting in the ground and covering the balls with soil and then watering them.
- F. The caliper of the trees shall be not less than the minimum size designated. Take caliper measurement six inches (6") above ground level up to and including four (4") caliper size and twelve inches (12") above ground for larger sizes. The trunk of each tree shall be a single trunk growing from a single unmutilated crown of roots. No part of the trunk shall be conspicuously crooked as compared with normal trees of the same variety. The trunk shall be free from sunscald, frost cracks, or wounds resulting from abrasions, fire or other causes. No pruning wounds shall be present having a diameter exceeding two inches (2") and such wounds must show vigorous bark on all edges. Plants shall not be pruned prior to delivery.
- G. Plants delivered by truck and plants requiring storage on site shall be properly wrapped and covered to prevent wind-drying and desiccation of branches, leaves or buds; plant balls should be firmly bound, unbroken, reasonably moist to indicate watering prior to delivery and during storage and tree trunks should be free from fresh scars and damage in handling. No trees with double-leaders or twin-heads shall be acceptable without the written approval of the Landscape Architect. The Contractor shall reject such plants at time of delivery by the nursery/supplier unless such plants were selected by the Landscape Architect as indicated by tags and seals. No plant material from cold storage will be accepted.

## 2.3 SOIL ADDITIVES

- A. Commercial fertilizer, manufactured compost, peat, humus or other additives shall be used to counteract soil deficiencies as recommended by the soil analysis and as directed by the Landscape Architect.

1. Commercial fertilizer shall be a product complying with the State and United States Fertilizer Laws. Deliver to the site in the original unopened containers that shall bear the manufacturer's Certificate of Compliance covering analysis which shall be furnished to the Landscape Architect. At least 50% by weight of the Nitrogen content shall be derived from organic materials. Fertilizer shall contain not less than the percentages of weight of ingredients as follows or as recommended by the soil analysis:

	Nitrogen	Phosphorus	Potash
For All Plants	10%	10%	10%

2. Fertilizer plan, including schedule and specific mix, must be submitted and approved by the Landscape Architect and the Owner's Representative.
- B. Ground dolomite limestone shall be an approved agricultural limestone containing not less than 85% of total calcium or magnesium carbonates. Limestone shall be ground to such fineness that 50% will pass through a 100 mesh sieve and 90% will pass through a 20 mesh sieve.
  - C. Humus shall be natural humus, reed peat or sedge peat. It shall be free from excessive amounts of zinc, low in wood content, free from hard lumps and in a shredded or granular form. According to the methods of testing of A.O.A.C., latest edition, the acidity range shall be approximately 5.5 pH to 7.6 pH and the organic matter shall be not less than 85% as determined by loss on ignition. The minimum water absorbing ability shall be 200% by weight on an oven-dry basis.
  - D. Peat moss shall be composed of the partly decomposed stems and leaves of any or several species of sphagnum moss. It shall be free from wood, decomposed colloidal residue and other foreign matter. It shall have an acidity range of 3.5 pH to 5.5 pH as determined in accordance with the methods of testing of A.O.A.C., latest edition. Its water absorbing ability shall be a minimum of 1,100% by weight on an oven-dry basis. Manufactured Compost of comparable qualities will be accepted in lieu of peat moss.
  - E. Superphosphate: Superphosphate shall be composed of finely ground phosphate rock as commonly used for agricultural purposes containing not less than 18% available phosphoric acid.
  - F. Water retention gel shall be used where appropriate. Mix with soil per manufacturer's directions.

#### 2.4 BARK MULCH

- A. Mulch shall be pine bark aged a minimum of six (6) months. The mulch shall be dark brown in color, free of chunks and pieces of wood thicker than one-quarter inch (1/4"). Mulch must be free of stringy material over three inches (3") in length and shall not contain, in the judgment of the Landscape Architect, an excess of fine particles. Mulch shall be 98% organic matter with the pH range of 3.5 to 4.5. Moisture content of packaged material shall not exceed 35%. Submit sample for the Landscape Architect's approval.
- B. Dyed mulch will not be approved.

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2.5 LAWN SEED MIX

- A. Seed Mix shall be "Black Beauty Ultra" by Jonathan Green Co. of Reading, PA or Approved Equal low-fertilizer-requirement mix designed to minimize need for irrigation.
- B. Grass seed for lawn areas shall be fresh, clean, dry, new crop seed, which meets the standard of the Federal Seed Act. Seed shall be mixed in proportion by weight and testing the minimum percentages of purity and germination. Seed shall be nursery grown seed composed of grasses grown from the following seed mixtures.
- Lawn Areas:
- | Approx % by Wt. | Common Name of Grass | % Germination |
|-----------------|----------------------|---------------|
| 70              | Tall Fescues         | 92            |
| 20              | Perennial Ryegrass   | 92            |
| 10              | Kentucky Bluegrass   | 85            |
- C. Weed seed shall not exceed 0.1% by weight. Tall Fescue shall be a mix of "Tonto," "Montana," "Dorado," or similar cultivar tall fescues. Bluegrass shall be "Madison," "Deepblue," "Prosperity," or similar cultivar Kentucky bluegrass. Perennial Rye shall be "Frontier," "Singular," or similar cultivar Perennial Ryegrass.

2.6 SPORTS FIELD MIX

- A. Seed Mix shall be "Blue Panther Kentucky Bluegrass Seed Mix" by Jonathan Green Co. of Reading, PA, or Approved Equal designed for sports applications.
- B. Grass seed for sports field areas shall be fresh, clean, dry, new crop seed, which meets the standard of the Federal Seed Act. Seed shall be mixed in proportion by weight and testing the minimum percentages of purity and germination. Seed shall be nursery grown seed composed of grasses grown from the following seed mixtures.
- C. Weed seed shall not exceed 0.1% by weight.

2.7 SOD MIX

- A. Sod shall be nursery grown sod composed of grasses grown from the following seed mixtures.
- | % by Weight | Common Name of Grass |
|-------------|----------------------|
| 70          | Tall Fescue          |
| 20          | Kentucky Bluegrass   |
| 10          | Perennial Ryegrass   |
- B. The sod shall be "Black Beauty Turf Type Fescue" grown by Sodco, Inc. of Slocum, Rhode Island, or other approved New England source; submit proposed sod specifications and source for approval.
- C. Weed seed shall not exceed 0.1% by weight. Tall fescue shall be a mix of "Golconda", "Montana", "Dorado", or similar cultivar tall fescues. Bluegrass shall be a mix of "Deepblue," "Prosperity," or similar cultivar Kentucky bluegrass. Perennial Rye shall be a mix of "Frontier," "Singular," or similar cultivar Perennial Ryegrass.

- D. Sod shall be machine cut at a uniform soil thickness of  $\frac{3}{4}$  inch, plus or minus  $\frac{1}{4}$  inch, at the time of cutting. Measurement for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and length shall be 5%. Broken pads and torn or uneven ends will not be acceptable. Sod shall be at least one (1) year old from time of original seeding.
- E. Sod shall be furnished and installed in either of the following dimensions, to be selected by the Contractor:
- F. In rectangular sod strips measuring 12 inches or 16 inches in width and from 4 feet to 6 feet in length, stored in rolls with the grass top side inverted so that the topsoil is to the exterior.
- G. Sod shall be harvested, delivered and installed within a period of 36 hours. Sod not transplanted within this period shall be inspected and approved by the Landscape Architect prior to its installation. Soil on sod pads shall be kept moist at all times.
- H. If delivered in multiple shipments, the sods shall match one another in texture and consistency, in the judgment of the Landscape Architect.

## 2.8 MEADOW GRASS SEED MIX

- A. Seed for meadow grass areas shall be fresh, clean, dry, new crop seed, which meets the standard of the Federal Seed Act. Seed shall be mixed in proportion by weight and testing the minimum percentages of purity and germination. Seed shall be nursery grown seed composed of grasses grown from the following species (or similar mix as approved by Landscape Architect):

<u>Botanical Name</u>	<u>Common Name</u>
Schizachyrium scoparium	Little Bluestem
Festuca rubra	Red Fescue
Sorghastrum nutans	Indian Grass
Chamaecrista fasciculata	Partridge Pea
Elymus canadensis	Canada Wild Rye
Elymus virginicus	Virginia Wild Rye
Verbena hastata	Blue Vervain
Asclepias tuberosa	Butterfly Milkweed
Sisyrinchium angustifolium	Narrowleafed Blue Eyed Grass
Rudbeckia hirta	Black Eyed Susan
Aster lateriflorus	Starved/Calico Aster
Aster novae-angliae	New England Aster
Eupatorium fistulosum	Hollow Stem Joe Pye Weed
Liatris spicata	Spiked Gayfeather
Solidago juncea	Early Goldenrod

- B. Weed seed shall not exceed 0.5% by weight.
- C. Seed mix shall be: New England Wildflower Seed Mix by New England Wetland Plants Inc. Amherst, MA (ph: 1.413.548.8000), or Approved Equal.

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## 2.9 DETENTION BASIN SEED MIX

- A. Seed for detention basin areas shall be, clean, dry, new crop seed, which meets the standard of the Federal Seed Act. Seed shall be mixed in proportion by weight and testing the minimum percentages of purity and germination. Seed shall be nursery grown seed composed of grasses grown from the following species (or similar mix as approved by Landscape Architect):

<u>Botanical Name</u>	<u>Common Name</u>
Elymus riparius	Riverbank Wild Rye
Festuca rubra	Creeping Red Fescue
Schizachyrium scoparium	Little Bluestem
Andropogon gerardii	Big Bluestem
Panicum virgatum	Switch Grass
Agrostis perennans	Upland Bentgrass
Bidens cernua	Nodding Bur Marigold
Eupatorium fistulosum	Hollow-Stem Joe Pye Weed
Aster novae-angliae	New England Aster
Eupatorium perfoliatum	Boneset
Verbena hastata	Blue Vervian
Juncus effusus	Soft Rush
Scirpus cyperinus	Wool Grass

- B. Weed seed shall not exceed 0.5% by weight.
- C. Seed mix shall be: New England Erosion Control/Restroation Mix for Detention Basins and Moist Sites by New England Wetland Plants Inc. Amherst, MA (ph: 1.413.548.8000), or Approved Equal.

## 2.10 EROSION CONTROL MAT

- A. Erosion Control Mat to be ECS-1B Single Net Straw Biodegradable Rolled Erosion Control Product by East Coast Erosion Control, 443 Bricker Road, Bernville, PA 19506 (ph1-800-582-4005) or approved equal to match specifications.
- B. Erosion control mat to be made of uniformly distributed 100% agricultural straw and one organic jute net securely sewn together with biodegradable. Net opening to be .5"x.1".
- C. The erosion control fabric to have a functional longevity of approximately 12 months. The erosion control fabric to meet Type 2.C specification requirements established by the Erosion Control Technology Council (ECTC) and Federal Highway Administration's (FHWA) FP-03 Section 713.17
- D. Erosion control fabric to come in 2 sizes. Standard to be 8' wide by 112.5' long, Mega to be 16' wide by 112.5' long.

## 2.11 INSECTICIDE

- A. No insecticide shall be used except as specifically approved in writing by the Landscape Architect and the Owner's Representative.

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## 2.12 WATER

- A. The Contractor shall be responsible to furnish his/her own supply of water to the site at no extra cost.
- B. All work injured or damaged due to the lack of water, or the use of too much water, shall be the Contractor's responsibility to correct. Water shall be free from impurities injurious to vegetation.
- C. All new trees shall be furnished with a Portable Drip Irrigation System (PDIS) water bag, "Gator Bags" or Approved Equal. PDIS water bags shall be UV-treated, reinforced polyethylene bags with a nylon toothed zipper extending from top to bottom of bag, capable of holding a minimum of 20 gallons of water, constructed so that they can be attached to the trees, which provide water from a minimum of three drip points.

## PART 3 - EXECUTION

### 3.1 FINE GRADING AND LOAM

- A. After the areas to be loamed have been brought to subgrade, and immediately prior to dumping and spreading the loam, the subgrade shall be loosened by disking or rototilling to a depth of at least three inches (3") to permit bonding of the loam to the subsoil. Remove all stones greater than two inches (2") and all debris or rubbish. Such material shall be removed from the site.
- B. Loam shall be placed and spread over approved areas to a depth sufficiently greater than six inches (6") so that after natural settlement and light rolling, the completed work will conform to the lines, grading and elevations indicated. Supply additional loam, after testing and approval, as may be needed to give the specified depths and finished grades under the contract without additional cost to the Owner.
- C. No subsoil or loam shall be handled in any way if it is in a wet, dry, or frozen condition.
- D. Sufficient grade stakes shall be set for checking the finished grades. Grades shall be established which are accurate to one-tenth (1/10th) of a foot either way. Connect contours and spot elevations with an even slope.
- E. After lime, fertilizer, and humus if required have been spread and incorporated into the bed, it shall be carefully prepared by scarifying or harrowing and hand raking. All large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter, and stones over one inch (1") in diameter shall be removed from the loam. Loam shall also be free of smaller stones in excessive quantities as determined by the Landscape Architect.
- F. The whole surface shall then be rolled with a hand roller weighing not more than 100 lbs. per foot of width. During the rolling, all depressions caused by settlement or rolling shall be filled with additional loam and the surface shall be regraded and rolled until presenting a smooth and even finish to the required grade. The finish grades shall be inspected by the Landscape Architect for approval before final acceptance.

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### 3.2 PLANTING

- A. Furnishing and planting of any plant material includes the digging of the holes, provision of soil additives and loam, furnishing the plants of specified size with roots in the specified manner, the labor of planting and mulching and guying and staking where called for.
- B. Season for Planting
  - 1. Spring:
    - a. Deciduous materials March 21 through May 15
    - b. Evergreen materials April 15 through June 1
  - 2. Fall:
    - a. Deciduous materials October 1 through December 1
    - b. Evergreen materials August 15 through October 15
- C. Planting
  - 1. Location for all plants and outlines for planting areas shall be staked on the ground by the Contractor for approval by the Landscape Architect before any plant pits or plant beds are dug.
  - 2. At least fifteen (15) days prior to the expected planting date, the Contractor shall request that the Landscape Architect provide a representative to select and tag stock to be planted under this Section. The Contractor shall provide for the transportation and overnight accommodations, if necessary, for the Landscape Architect's representative during the period of time required to select and tag the plant material, at no extra cost to the Owner.
  - 3. Plants shall be selected by the Landscape Architect at the place of growth for conformity to specification requirements as to quality, size, and variety. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work. Cost of replacement shall be borne by the Contractor.
  - 4. Plant pits shall be circular pits with sloping sides, except for plants specifically indicated to be planted in beds. Holes for trees and shrubs shall be at least two feet (2') greater in diameter than the ball, and shall be at least three (3) times the diameter of the ball for trees where space allows, and shall be of a depth that maintains the plant's prior relation to finish grade. Bottom of pit shall be flat or deepest at the perimeter. If pit is dug deeper than required to maintain plant's relation to finish grade, then soil replaced under root ball shall be compacted to prevent subsequent settling of tree or shrub. If soil at bottom of pit is impermeable or poorly drained, pit shall be dug one extra foot, backfilled with planting soil mix, and compacted before installing plant.
  - 5. After excavation, fill pit twice successively with water. If water does not drain out of pit at a minimum of two inches per hour, provisions for drainage must be made. Contractor shall document drainage test results for review by Landscape Architect.



6. Topsoil, organic material and fertilizer mix for planting soil mix shall be thoroughly premixed in the proportions of one (1) part of organic material with four (4) parts of topsoil together with fertilizer at the rate determined by soil test. The organic material to be added shall be as directed by the Landscape Architect. One part of existing soil shall be mixed with two parts of planting soil mix for use in back filling around root ball. Maintain at all times during the planting operations one or more stockpiles of approved planting soil mix.
7. Install slow release fertilizer packets per manufacturers' directions with each newly planted tree.
8. All plant roots and earth balls must be damp and thoroughly protected from sun and wind from the beginning of the digging operation, during transportation and on the ground until the final planting. The plants shall be planted in the center of the holes and at the same depth as they previously grew (see a. below). Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structures. Remove burlap, rope, wires, etc., from the sides and tops of root balls. Do not pull burlap out from under root balls. Any girdling roots or badly damaged roots must be cleanly pruned off. Planting soil mix shall be backfilled in layers of not more than six inches (6") and each layer watered sufficiently to settle before the next layer is put in place. Enough planting soil mix shall be used to bring the surface to finish grade when settled. A saucer shall be formed around each plant at a depth of six inches (6") for trees.
  - a. The Root Flare of each plant shall be located at the finish grade and visible. All planting depths shall be inspected by the Landscape Architect and the Owner's Representative, and if not at the proper depth shall be corrected at the Contractor's expense.
- D. All plants shall be flooded with water twice within the first 24 hours of the time of planting and all plants during the maintenance period shall be watered at least twice each week. At each watering the soil around each plant shall be thoroughly saturated. If sufficient moisture is retained in the soil, as determined by the Landscape Architect, the required watering may be reduced. Trees will require a minimum of ten (10) gallons of water each.
- E. Mulch material shall be placed over entire saucer areas of individual trees and over the entire area of planting beds to a depth of three inches (3") after settlement, not later than one (1) week after planting. No mulch shall be applied prior to the first watering of plant materials. Mulch shall be pulled back two inches (2") from tree trunks.
- F. Portable Drip Irrigation System watering bags shall be installed as directed by the bag manufacturer, and shall be kept filled as necessary to maintain optimum health.
- G. Antidesiccant shall be applied to all plants before digging at the nursery and/or as directed by the Landscape Architect once the plants have been delivered to the site.

- H. Antidesiccant shall be applied to all evergreen plants in the late fall as directed by the Landscape Architect.
- I. If planting is done after lawn preparation or installation proper protection of lawn areas shall be provided and any damage resulting from planting operations shall be repaired immediately at no cost to the Owner.
- J. In the event that rock or underground construction work or obstructions are encountered in any plant pit or bed excavation work to be done under this Contract, alternate locations may be selected by the Landscape Architect.
- K. Absolutely no debris may be left on the site. Excavated material shall be removed as directed by the Landscape Architect. Repair any damage to site or structures to restore them to their original condition as directed by the Landscape Architect, at no cost to the Owner.

### 3.3 SOIL ADDITIVES

- A. Follow all recommendations for soil additives as determined by an approved Soil Testing Laboratory, and all manufacturers' instructions pertaining to additives.

### 3.4 BARK MULCH

- A. Contractor shall install approved bark mulch material to the limits and depths shown on the Drawings and specified herein.

### 3.5 HYDROSEEDING

- A. Limit of seeding shall be shown on the Drawings. All areas on the plan shall be loamed and seeded only after written approval of the finished grading or as directed by the Landscape Architect. All seeded areas are to be hydroseeded.  

The actual planting of seed shall be done, however, only during periods within this season which are normal for such work as determined by weather conditions and be accepted practice in this locality. At his/her option and on his/her responsibility the Contractor may plant seed under unseasonable conditions without additional compensation, but subject to the Architect's approval as to time and methods.
- B. Planting may be done between August 15 and October 15, or between April 15 and June 15.
- C. Soil additives shall be spread and thoroughly incorporated into the later of loam and the upper 1 inch of the underlying subsoil by harrowing or other methods approved by the Architect. The following soil additives shall be incorporated:
  - 1. Ground limestone as required by soil analysis to achieve a pH of 6.0 to 6.5.
  - 2. Fertilizer as required by soil analysis.
  - 3. Superphosphate at the rate of 20 lbs. Per 1,000 square feet.
  - 4. Humus as required by soil analysis.
  - 5. Compost at a rate of 1 part compost per 4 parts planting loam.

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- D. Seeding of lawns shall be done only by experienced workmen under the supervision of qualified foreman. Seeding shall consist of soil preparation, rolling, hydroseeding, weeding, fertilizing, watering and otherwise providing all labor and materials necessary to secure the establishment of acceptable turf.
  - E. The soil on which the seed is spread shall be reasonably moist and shall be watered, if directed by the Architect. The seeded areas shall be watered evenly and at a rate of 5 gallons per square yard, unless otherwise directed by the Architect.
  - F. Contractor shall place and maintain barriers (in a neat condition) around hydroseeded areas to keep people off during the first sixty (60) days.
  - G. The actual seeding of lawns shall be done only during periods within the season which are normal for such work as determined by weather conditions and by accepted practice in this locality, except as approved by the Architect.
  - H. The application of grass seed, fertilizer, limestone, and a suitable wood fiber or other mulch shall be accomplished in one operation for hydroseeding.
  - I. Hydroseeding shall be done by use of an approved spraying machine, which shall be operated only by personnel thoroughly familiar with this type of seeding operation.
  - J. Prior to starting work, Contractor shall furnish the Architect with a certified statement as to the number of pounds of materials to be used per 100 gallons of water and the number of square feet to be covered with the quantity of solution in the hydroseeder.
    - 1. Materials shall be mixed with water in the machine and kept in an agitated state in order that the materials may be uniformly suspended in the water.
    - 2. Solution shall be sprayed evenly over the area so that resulting deposits of all materials shall equal the required rates.
    - 3. Spraying equipment shall be thoroughly cleaned and flushed prior to start of work and after every ten acres.
    - 4. When inoculum is required, if the inoculum is left in the solution with fertilizer for longer than thirty minutes, a fresh charge of inoculum shall be added to the mixture.

### 3.6 MEADOW GRASS SEED MIX & DETENTION BASIN SEED MIX

- A. Always apply on clean bare soil. Preparation of a clean weed free soil surface is necessary for optimal results. The mix may be applied by hydro-seeding, by mechanical spreader, or on small sites it can be spread by hand. Lightly rake, or roll to ensure proper seed to soil contact. Late Spring and early Summer seeding will benefit with a light mulching of weed-free straw to conserve moisture. If conditions are drier than usual, watering may be required. Fertilization is not required unless the soils are particularly infertile.
- B. Best results are obtained with a Spring seeding. Late Fall and Winter dormant seeding require an increase in the seeding rate.

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### 3.7 SODDING

- A. Limit of sodding shall be shown on the Drawings. All areas on the plan shall be loamed and sodded only after written approval of the finished grading or as directed by the Landscape Architect.
- B. Planting season for sod shall be from April 15 to June 1. The actual planting of sod shall be done, however, only during periods within this season which are normal for such work as determined by weather conditions and be accepted practice in this locality. At this option and on his responsibility the Contractor may plant sod under unseasonable conditions without additional compensation, but subject to the Landscape Architect's approval as to time and methods.
- C. Soil additives shall be spread and thoroughly incorporated into the later of loam and the upper 1 inch of the underlying subsoil by harrowing or other methods approved by the Landscape Architect. The following soil additives shall be incorporated:
  - 1. Ground limestone as required by soil analysis to achieve a pH of 6.0 to 6.5.
  - 2. Fertilizer as required by soil analysis.
  - 3. Superphosphate at the rate of 20 lbs. Per 1,000 square feet.
  - 4. Humus as required by soil analysis.
- D. Sodding of lawns shall be done only by experienced workmen under the supervision of qualified foreman. Sodding shall consist of soil preparation, sodding, rolling, pegging, weeding, fertilizing, watering and otherwise providing all labor and materials necessary to secure the establishment of acceptable turf.
- E. The soil on which the sod is laid shall be reasonably moist and shall be watered, if directed by the Landscape Architect. The sod shall be laid smoothly, edge to edge, and where continuous or solid sodding is called for on the plans sod shall be laid with the longest dimension parallel to the contours. Sodding shall start at the base of slopes and progress upward in continuous parallel rows. Vertical joints between sods shall be staggered. Immediately after laying, so shall be pressed firmly into contact with the sod bed by tamping, rolling, or by other approved method – press firmly as to eliminate all air pockets, provide tree and even surfaces, ensure knitting and protect all exposed sod edges, but without displacement of the sod or deformation of the sod surfaces. The sodded areas shall be watered evenly and at a rate of 5 gallons per square yard, unless otherwise directed by the Landscape Architect.

### 3.8 EROSION CONTROL FABRIC

- A. Install as shown in Drawings and per Manufacturer's instructions.
- B. Erosion control mat shall be secured by 11 gauge staples at a minimum size of 6" long with a 1" crown. Staple pattern should reflect the layouts for the corresponding slope given by the manufacturer.

### 3.9 MAINTENANCE AND PROTECTION OF PLANTS AND LAWN AREAS

- A. Maintenance shall begin immediately after an area is planted or sodded and shall continue until final acceptance. The minimum maintenance period shall be

ninety (90) calendar days after completion of all plant installations including lawn. Watering and mowing shall be done by the Contractor for the full 90 days. Final acceptance of the plant material cannot be made until the full 90 maintenance period has elapsed.

- B. Maintenance shall include replacement of shrubs, mowing, watering, weeding, and fertilizing.
- C. Watering of Lawn Areas:
  - 1. First week: The Contractor shall provide all labor and arrange for all watering necessary for rooting of the plant materials. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary during the first week and in sufficient quantity to maintain moist soil to a depth of at least 4 inches. Watering shall not be done during the heat of the day to help prevent wilting.
  - 2. Second and Subsequent weeks: The Contractor shall water the lawn and plantings as required to maintain adequate moisture, until final acceptance, in the upper 4 inches of soil.
  - 3. Watering shall be done in a manner that will provide uniform coverage, prevent erosion due to application of excessive quantities over small areas, and prevent damage to the finished surface by the watering equipment. The Contractor shall furnish sufficient watering equipment to apply one (1) complete coverage to the lawn areas and plantings in an eight (8) hour period.
- D. Watering of Tree Plantings:
  - 1. Portable Drip Irrigation System watering bags shall be kept filled as needed to maintain optimal plant health. Bags shall be filled a minimum of once each week regardless of rain conditions. The contractor shall be responsible for ensuring that watering bags are kept full for one full growing season after installation.
- E. Mowing:
  - 1. The first mowing of lawn areas shall not be attempted until the lawn is firmly rooted and secure in place. Not more than 40% of the grass leaf shall be removed by initial or subsequent mowings. Grass height shall be maintained between 2 inches and 2-1/2 inches unless otherwise specified. Thereafter grass shall be maintained at 2 inches until acceptance.
- F. Fertilizing:
  - 1. A second application of fertilizer, as specified herein and as outlined in the fertilizing schedule to be submitted by the Contractor, shall be applied approximately 6 weeks after the sod has been installed as directed by the Landscape Architect. Fertilizer shall be applied at the rate of 10 pounds per 1,000 square feet or as otherwise approved as part of the fertilizing schedule.

END OF SECTION

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PLANTING

SECTION 33 05 13

MANHOLES AND STRUCTURES

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.
- B. The General Contractor shall either perform the work of this section with its own forces or shall subcontract such work to a subcontractor who will furnish a performance and payment bond for the complete scope of work and listing the City of Framingham as the co-obligee. Such bond shall be procured from a surety that is currently licensed to do business in Massachusetts and is currently listed on the United States Treasury Department circular 570. A copy of such bond shall be submitted to the Owner's Project Manager for approval and shall be in place prior to the subcontractor commencing any work on the project.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
  - 1. Install precast concrete manholes, catch basins, frames and covers, grates, manhole rungs, platforms, and appurtenances all as shown on the Drawings and as specified herein.
- B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
  - 1. Section 310000 - EARTH MOVING
  - 2. Section 334100 - STORM UTILITY DRAINAGE PIPING
  - 3. Section 333100 - SANITARY UTILITY SEWERAGE PIPING

1.3 REFERENCES

- A. American Concrete Institute:
  - 1. ACI 318 - Building Code Requirements for Structural Concrete.
  - 2. ACI 530/530.1 - Building Code Requirements for Masonry Structures and Specifications for Masonry Structures.
- B. ASTM International:
  - 1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.

2. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
3. ASTM C32 - Standard Specification for Sewer and Manhole Brick
4. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
5. ASTM C55 - Standard Specification for Concrete Brick.
6. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
7. ASTM C150 - Standard Specification for Portland Cement
8. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes
9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
11. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
12. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
13. ASTM D4097 - Contact Molded Glass Fiber Reinforced Chemical Resistant Tanks
14. ASTM D4101 - Standard Specification for Propylene Plastic Injection and Extrusion Materials

C. American Association of State Highway and Transportation Officials (AASHTO)

D. Occupational Safety and Health Administration (OSHA)

#### 1.4 DESIGN REQUIREMENTS

- A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.
- B. Design of Lifting Devices for Precast Components: In accordance with ASTM C913.
- C. Design of Joints for Precast Components: In accordance with ASTM C913; maximum leakage of 0.025 gallons per hour per foot of joint at 3 ft. of head.

#### 1.5 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate manhole locations, elevations, and sizes and elevations of penetrations.
- C. Product Data: Submit cover and frame construction, features, configuration, dimensions.

## 1.6 QUALITY ASSURANCE

- A. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the Engineer or other representative of the Owner. Such inspection may be made at the place of manufacture, or on the work after delivery, or at both places and the materials shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein; even though samples may have been accepted as satisfactory as the place of manufacture. Material reject after delivery to the job shall be marked for identification and shall be removed from the job at one. All materials that have been damaged after delivery shall be rejected, and if already installed, shall be acceptably repaired, if permitted, or removed and replaced, entirely at the Contractor's expense.
- B. At the time of inspection, the materials will be carefully examined for compliance with the applicable ASTM standard specification and this Section with the approved manufacturer's drawings. All manhole sections shall be inspected for general appearance, dimension, scratch strength, blisters, cracks, roughness, soundness, and other surface or structural imperfections. The surface shall be dense and close-textured.
- C. Imperfections in manhole sections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at seven days and 5,000 psi at 28 days, when tested in 3 inch x 6 inch cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the approval of the Engineer.

## 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

## 1.8 DELIVERY, STORAGE AND HANDLING

- A. Section 016000 - PRODUCT REQUIREMENTS: Product storage and handling requirements.
- B. Comply with precast concrete manufacturer's instructions for unloading, storing, and moving precast manholes.
- C. Store precast concrete manholes to prevent damage to Owner's property or other public or private property. Repair property damaged from materials storage.
- D. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.



1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - PRODUCT REQUIREMENTS.
- B. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.
- C. Cold Weather Requirements: ACI 530.

PART 2 - PRODUCTS

2.01 PRECAST CONCRETE MANHOLE SECTIONS

- A. Precast concrete barrel sections and transition top sections shall conform to ASTM C478 and meet the following requirements:
  - 1. Manholes shall have a minimum 48 inch interior diameter with a wall thickness of not less than 5 inch.
  - 2. Top sections shall be eccentric except that barrel sections shall be used where shallow pipe cover requires a top section less than 4 feet.
  - 3. Barrel sections shall have tongue and groove joints. Manholes shall be manufactured in the configuration shown on the Drawings with the bell of the manhole section pointing down.
  - 4. All sections shall be cured by an approved method and shall not be shipped or subjected to loading until the concrete compressive strength has attained 3,000 psi and not before five days after fabrication or repair, whichever is longer.
  - 5. Precast concrete barrel sections with top slabs and precast concrete transition sections shall be designed for a minimum of HS-20 loading plus the weight of the soil above at 120 pcf.
  - 6. The date of manufacture and the name and trademark of the manufacturer shall be clearly marked on the inside of each precast section.
  - 7. Precast concrete bases shall be constructed of and installed as shown on the Drawings. The thickness of the bottom slab of precast bases shall not be less than the manhole barrel sections or top slab, whichever is greater.
  - 8. Knockout panels shall not be permitted.

2.02 CATCH BASINS

- A. Precast reinforced concrete catch basin sections shall conform to the applicable requirements of ASTM C478, latest revision.
- B. Basin shall be precast reinforced concrete 4 feet in diameter with penetrations cast into the basin for pipe connection; knockout panels shall not be permitted. Basins shall have a minimum wall thickness of 5 inch and a minimum bottom thickness of 6 inches. Basins shall have a sump of 4 feet. Top sections shall be a flat slab and have a minimum of 8 inches for support of cast iron frame and grate. The hole in the top section shall be 24 inches square size to accommodate frame and cover and be eccentric. The hole in the top section shall be located over the side opposite to the hooded outlet to facilitate future cleaning operations.

- C. All concrete shall have a minimum compressive strength of 4,000 psi and a live load design base for all catch basins shall be HS-20 loading.
- D. All catch basins shall be fitted with a hooded outlet. The hoods are to be positioned so they will not interfere with future cleaning operations. The hooded outlet cover shall be fabricated from marine grade fiberglass, stainless steel (18-8) attachment hardware, pressure sensitive oil resistant foam rubber gasket, PVC Schedule 40 fittings, and pipe for anti-siphon device.
- E. Bedding material under catch basins and drain manholes shall conform to the requirements for of the Specifications for pipe bedding. A minimum of 12 inches of 3/4" crushed stone is required to provide a uniform base. If the material at the elevation that catch basins are to be set on is not suitable to support them, then this material shall be removed to a depth that will support the structure. The material approved by the Engineer shall be used to replace the removed material and be compacted before setting the base.
- F. Catch basin frames and grates/covers shall be set at a finished elevation 1 inch below finish pavement elevation.

#### 2.03 BRICK MASONRY

- A. The bricks shall be good, sound, hard and uniformly burned, regular and uniform in shape, of compact size and texture and satisfactory to the Engineer. Underburned or salmon brick will not be acceptable and only whole brick shall be used unless otherwise permitted. In case bricks are rejected by the Engineer, they shall be immediately removed from the site of the work and satisfactory bricks used thereafter.
  - 1. Bricks for the channels and sleeves shall comply with ASTM C32 for sewer brick; Grade SS (from clay or shale) except that the mean of five tests for absorption shall not exceed 8% and no individual brick shall exceed 11%.
  - 2. Bricks for building up and leveling the manhole frames shall comply with ASTM C62.
- B. Mortar used in the brickwork shall be composed of one part Type II Portland cement conforming to ASTM C150 and sand to which a small amount of hydrated lime not to exceed 10 lbs to each bag of cement shall be added.
- C. The sand used shall be washed, cleaned, screened, sharp and well graded as to different sizes and with no grain larger than will pass a No. 4 sieve. It shall be free from vegetable matter, loam, organic or other materials of such nature or quantity to render it unsatisfactory.
- D. The hydrated lime shall also conform to ASTM C207.

#### 2.04 FRAMES, COVERS AND GRATES

- A. Manufacturers:
  - 1. All manufacturers producing such products shall be considered.
  - 2. Substitutions: Section 016000 - PRODUCT REQUIREMENTS.

- B. Manhole frames and covers shall be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind that render them unfit for the service for which they are intended. Manhole covers and frame seats shall be machined to a true surface. Castings shall be thoroughly cleaned and subject to hammer inspection. Cast iron shall conform to ASTM A48, Class 30.
- C. Manhole covers shall have a diamond pattern, pick holes, and the word 'SEWER', 'DRAIN', or as appropriate, cast in 3 in. letters.
- D. Inlet frames and grates shall be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind that render them unfit for the service for which they are intended. Catch basin grates and frame seats shall be machined to a true surface. Castings shall be thoroughly cleaned and subject to hammer inspection. Cast iron shall conform to ASTM A48, Class 30.
- E. Grates, if located in a walking area, shall have spaces no greater than 1/2 inch wide in one direction. If gratings have elongated openings, then they shall be placed so that the long dimension is perpendicular to the dominant direction of travel.

#### 2.05 JOINTING PRECAST MANHOLE SECTIONS

- A. Tongue and groove joints shall be sealed with either a round rubber o-ring gasket or a preformed flexible joint sealant. The o-ring shall conform to ASTM C443.
- B. Joints shall be designed and manufactured so that the completed joint will withstand an internal water pressure of 15 psi without leakage or displacement of the gasket or sealant.

#### 2.06 MANHOLE RUNGS

- A. Manhole rungs shall conform to the requirements of ASTM C478 and be of the following types:
  - 1. Manhole rungs shall be steel reinforced copolymer polypropylene plastic. Rungs shall be 14 inches wide. Copolymer polypropylene shall conform to ASTM D4101. Steel reinforcing shall be 1/2 inch diameter, grade 60 conforming to ASTM A615 and shall be continuous throughout the rung. The portion of the legs to be embedded in the precast section shall have fins and be tapered to insure a secure bond.

#### 2.07 PIPE CONNECTION TO MANHOLE

- A. Manhole pipe connections may be accomplished in the following ways:
  - 1. The 'Lock Joint Flexible Manhole Sleeve' shall be cast in the precast manhole base. The steel strap shall be protected from corrosion with a bituminous coat.
  - 2. 'A-Lok' shall be a rubber like gasket cast in the precast manhole base. The rubber gasket shall be case into a formed opening in the manhole.
  - 3. 'Kor-N-Seal' joint shall be installed as recommended by the manufacturer. The stainless steel clamp shall be protected from corrosion with a bituminous coat.

- B. Clear Cover Opening: 24 inch diameter, or as otherwise indicated on Drawings.
- C. Steps: 12 inch wide, 16 inch on center vertically, set into manhole, or as otherwise indicated on Drawings.

#### 2.08 DAMPPROOFING

- A. The dampproofing shall be Hydrocide 648 by Sonneborn Building Products, Dehydratine by A.C. Horn, Inc., Meadows Trowel Mastic, or approved equal.

#### 2.09 CONFIGURATION

- A. Shaft Construction: Concentric with eccentric cone top section; lipped male/female joints; sleeved to receive pipe sections.
- B. Shape: Cylindrical.
- C. Clear Inside Dimensions: 48 inches, or as otherwise indicated on Drawings.
- D. Design Depth: As indicated on Drawings.
- E. Clear Cover Opening: 24 inch diameter, or as otherwise indicated on Drawings.
- F. Steps: 12 inch wide, 16 inch on center vertically, set into manhole, or as otherwise indicated on Drawings.

#### 2.10 BEDDING MATERIALS

- A. Bedding and Cover: 3/4 inch Crushed Stone in accordance with Section M2.01.4 of the MHD Standard Specifications.
- B. Soil Backfill from Around Manhole: In pavement areas where controlled density fill is not specified, provide Ordinary Fill to the sub-base of the pavement, and then provide the required sub-base material for the pavement section. In grassed areas where controlled density fill is not specified, provide Ordinary Fill to a point 6 inches below finished grade, then Manufactured Topsoils to finished grade.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify built-in items are in proper location, and ready for roughing into Work.
- C. Verify correct size of manhole excavation.

### 3.02 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.
- B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.
- C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

### 3.03 INSTALLATION

- A. Excavation and Backfill:
  - 1. Excavate for manholes to location and depth shown in accordance with Section 310000 - EARTHWORK and as otherwise specified herein. Provide clearance around sidewalls of structure for construction operations.
  - 2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes in dry trench.
  - 3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.
- B. Place base pad, trowel top surface level.
- C. Install manholes supported at proper grade and alignment on crushed stone bedding as shown on Drawings.
- D. Backfill and compact excavations for manholes in accordance with Section 310000 - EARTHWORK.
- E. Form and place manhole cylinder plumb and level, to correct dimensions and elevations.
- F. Cut and fit for sleeves.
- G. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour to form continuous drainage channel, as indicated on Drawings.
- H. Set cover frames and covers level without tipping, to correct elevations.
- I. Coordinate with other sections of Work to provide correct size, shape, and location.

### 3.04 PRECAST CONCRETE INSTALLATION

- A. Lift precast components at lifting points designated by manufacturer.
- B. When lowering precast structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

- C. Set precast structures bearing firmly and fully on crushed stone bedding, compacted in accordance with State of MHD specifications.
- D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.
- E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.
- F. Joint sealing materials may be installed on site or at manufacturer's plant.
- G. Verify installations satisfy required alignment and grade.
- H. Cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.
- I. Cut pipe to finish flush with interior of structure.
- J. Shape inverts through manhole as shown on Drawings.

### 3.05 FRAME AND COVER INSTALLATION

- A. Set frames using mortar and masonry. Install radially laid sewer brick with 1/4 inch thick vertical joints at inside perimeter. Lay sewer brick in full bed of mortar and completely fill joints. Where more than one course of sewer brick is required, stagger vertical joints. No more than three courses of sewer brick shall be permitted.
- B. Set frame and cover 2 inches above finished grade for manholes with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.

### 3.06 FIELD QUALITY CONTROL

- A. Sections 014000 - QUALITY REQUIREMENTS, 016000 - PRODUCT REQUIREMENTS and 017700 - CLOSEOUT PROCEDURES.
- B. Vertical Adjustment of Existing Manholes:
  - 1. Where required, adjust top elevation of existing manholes to finished grades shown on Drawings.
  - 2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.
  - 3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated Drawings.

### 3.07 LEAKAGE TESTS

- A. Leakage tests shall be made and observed by the Engineer on each manhole. The test shall be as described below:
- B. Vacuum Test (required on all new manholes):
1. The test shall be made using an inflatable compression band, vacuum pump, and appurtenances specifically designed for testing manholes. Test procedures shall be in accordance with the equipment manufacturer's recommendations. Contactor shall be fully familiar with the vacuum testing equipment and provide a minimum of four hours of instruction by a factory authorized representative at the outset of the project.
  2. Each manhole shall be test immediately after assembly including the connection of pipes and prior to backfilling.
  3. All lift holes shall be plugged with non-shrink grout and all pipes entering the manhole shall be plugged and braced to prevent the plug from being drawn into the manhole.
  4. After test equipment is in place the test shall be run at the following rate and test times:
    - a. For 4 foot diameter manholes:
      - 1) Initial test pressure – 10 inches Hg
      - 2) Test Time – 1 inch Hg drop to 9 inches Hg in one minute allowable for 0 feet to 10 feet deep manholes.
    - b. If the pressure drop exceeds 1 inch Hg in the specified time the manhole shall be repaired in accordance with approved procedures and retested.
    - c. If a manhole fails to meet a 1 inch Hg drop in the specified time after repairs the unit shall be water exfiltration tested as specified below and repaired as necessary.
- C. Exfiltration Test (required as described above):
1. Assemble manhole in place; fill and point all lifting holes and exterior joints within 6 feet of the ground surface with an approved non-shrinking mortar. Test prior to placing the shelf and invert before filling and pointing the horizontal joints below 6 feet of depth. Lower groundwater table below bottom of manhole for the duration of the test. Plug all pipes and other openings into the manhole and brace to prevent blowout.
  2. Fill manhole with water to the top of the cone section. If the excavation has not been backfilled and no water is observed moving down the surface of the manhole, the manhole is satisfactorily watertight. If the test, as described above is unsatisfactory to the Engineer, or if the manhole excavation has been backfilled, continue the test. A period of time may be permitted to allow for absorption. Following this period, refill manhole to the top of the cone, if necessary, and allow at least eight hours to pass. At the end of the test period, refill the manhole to the top of the cone again, measuring the volume of water added. Extrapolate the refill amount to a 24 hour leakage rate. If the manhole fails this requirement, but the leakage does not exceed three gallons per vertical foot per day, repairs by approved methods may be as directed by the Engineer. If leakage due to a defective joint exceeds this amount, the manhole shall be rejected. Uncover the rejected manhole as necessary to disassemble,

- reconstruct, or replace it as directed by the Engineer. Retest the manhole, and if satisfactory, fill and point the interior joints.
3. No adjustment in the leakage allowance may be made for unknown causes such as leaking plugs, absorptions, or other. It will be assumed that all loss of water during the test is a result of leaks through the joints or through the entrance.
  4. An infiltration test may not be substituted for an exfiltration test if the groundwater table is above the highest joint in the manhole. If there is no leakage into the manhole as determined by the Engineer, the manhole will be considered watertight. If the Engineer is not satisfied, testing shall be performed as described herein.

### 3.08 CLEANING

- A. All new manholes shall be thoroughly cleaned of all silt, debris, and foreign matter of any kind, prior to final inspection.

END OF SECTION



SECTION 33 10 00

WATER UTILITIES

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.
- B. The General Contractor shall either perform the work of this section with its own forces or shall subcontract such work to a subcontractor who will furnish a performance and payment bond for the complete scope of work and listing the City of Framingham as the co-obligee. Such bond shall be procured from a surety that is currently licensed to do business in Massachusetts and is currently listed on the United States Treasury Department circular 570. A copy of such bond shall be submitted to the Owner's Project Manager for approval and shall be in place prior to the subcontractor commencing any work on the project.

1.2 SUMMARY

- A. Section Includes:
  - 1. Pipe and fittings for site water line including water mains and laterals.
  - 2. Valves.
  - 3. Hydrants.
  - 4. Backflow preventers.
  - 5. Underground pipe markers.
  - 6. Bedding and cover materials.
- B. Related Sections:
  - 1. Section 310000 - EARTH MOVING.
  - 2. Section 311000 - SITE CLEARING.
  - 3. Section 321216 - BITUMINOUS CONCRETE PAVING.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10 lb. Rammer and an 18 in. Drop.
- B. American Society of Mechanical Engineers:
  - 1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
  - 2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

- C. American Society of Sanitary Engineering:
1. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent.
  2. ASSE 1013 - Reduced Pressure Principle Backflow Preventers.
- D. ASTM International:
1. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
  2. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
  3. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>).
  4. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft<sup>3</sup>).
  5. ASTM D1785 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
  6. ASTM D2241 - Standard Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
  7. ASTM D2466 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
  8. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
  9. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  10. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
  11. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
  12. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- F. American Water Works Association:
1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
  2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
  3. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  4. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
  5. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
  6. AWWA C502 - Dry-Barrel Fire Hydrants.
  7. AWWA C504 - Rubber-Sealed Butterfly Valves.
  8. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in. (50 mm) Through 24in. (600 mm) NPS.
  9. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
  10. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
  11. AWWA C606 - Grooved and Shouldered Joints.
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13. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
14. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
15. AWWA C702 - Cold-Water Meters - Compound Type.
16. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
17. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
18. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in., for Water Service.
19. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

G. Underwriters Laboratories Inc.:

1. UL 246 - Hydrants for Fire - Protection Service.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data on pipe materials, pipe fittings, valves, hydrants, and accessories.
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017700 - CLOSEOUT PROCEDURES.
- B. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with MHD and MA DEP standards, including the potable water supply construction permit issued for this project.
- B. Maintain one copy of each document on site.
- C. Valves: Manufacturer's name and pressure rating marked on valve body.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - PRODUCT REQUIREMENTS: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver and store valves in shipping containers with labeling in place.

## PART 2 - PRODUCTS

### 2.1 WATER PIPING

- A. Pipe shall be ductile iron push on joint pipe manufactured in accordance with the requirements of ANSI/AWWA C151/A21.51 and shall be thickness Class 52 with a minimal wall thickness of 0.31 inch for 6 inch pipe, 0.33 inch for 8 inch pipe, 0.35 inch for 10 inch pipe, and 0.37 inch for 12 inch pipe. Pipe thickness shall be designated in accordance with ANSI/AWWA C150/A21.50 and shall be based on laying connections and internal pressure as specified in the project plans. The rated working pressure shall be a minimum of 350 psi. Push on joints for such pipe shall be in accordance with ANSI A21.11/AWWA C111. Only in special circumstances will mechanical joints be allowed with the prior approval of the Engineer. Pipe shall have cement mortar lining twice the normal thickness and tar coating in accordance with ANSI A21.4-90/AWWA C104. Pipe lengths shall be standard 18 feet or 20 feet unless otherwise approved. Bell joint end shall have a rubber gasket to assure a permanent seal. The spigot end shall have a slight bevel for easy passage through gasket.
- B. Ductile iron water pipe shall be installed in a flat bottom trench, backfilled lightly with a selected material removed in excavation with nothing larger than 2 inches in diameter. This material will be consolidated to centerline of pipe; after this is done the same materials will be used to provide a 12 inch cover over the top of the installed main.
- C. Ductile iron water pipe shall not be laid with a deflection of more than 12 inches.

### 2.2 HYDRANTS

- A. Break flange type, (AWWA C502, latest revision), steamer connection 4 inch, 2-2¼ inch side hose connections, national standard threads, positive drain, open left with pentagon operating nut, inlet 6 inches, 7 inch diameter barrel and mechanical joint hub. Hydrants shall be restrained back to main, thrust block behind, ¾ inch stone from bottom of hydrant boot to 8 inches over drain port, and 5-¼ inch valve opening. All hydrants shall be set with steamer facing the street or parking lots with a minimum of 15 inches from finish grade to bottom of steamer connection. All hydrants shall be painted per City of Framingham Water Department requirements.
- B. Hydrants shall be designed for 250 psi working pressure and shall conform in every respect to the specifications adopted by the AWWA. Hydrants shall be given two coats of quality paint after installation.
- C. Hydrants shall be identical to present City of Framingham Fire and/or Water Department requirements.
- D. The City has standardized on American Darling Model No. B-62B as manufactured by American Flow Control Inc.
- E. Installation: No hydrant shall be located within 20 feet of a driveway curb cut. Maximum allowed distance for hydrant back from face of berm is 8 feet with a minimum distance of 2 feet. Bury depth shall be 5'-6".

- F. There shall be no plantings such as, but not limited to, shrubs or bushes, planted within 10 feet of any hydrant.

## 2.3 SERVICE BOXES

- A. Plug cover to be in cement or asphalt, the word 'WATER' shall be cast into the cover, the box will be of a length in height to accommodate any bury depth with 1 foot adjustment height. The overall height is to be 4-1/2 to 5-1/2 feet unless otherwise approved by the engineer. The service box will be reinforced at arch and pipe ring area and will accommodate up to a 1 inch curb stop. Service box rod will have a heavy ductile iron yoke with a brass copper pin. Service boxes shall be identical to present City of Framingham Water Department requirements.

## 2.4 VALVE BOXES

- A. Valve boxes shall be cast iron, tar coated, two piece adjustable sliding type with a top flange and a minimum inside shaft diameter of 5-1/4 inches. Boxes shall have the word 'WATER' clearly cast into the cover. Bell end of the lower sections shall in all cases be sufficiently large enough to fit over the stuffing boxes of the valves. Valve boxes shall be buried 5 feet or deeper to accommodate installation and have a minimum of 12 inch overlap so there is 1 foot adjustment. A positive centering cap made of high strength plastics should be placed over the valve onto which the valve box will be centered. Valve boxes shall be identical to present City of Framingham Water Department requirements.

## 2.5 GATE VALVES

- A. Manufacturers: Shall be A.F.C. Series 2500 Resilient Seat, Mueller Resilient Seat, Metro Seat #5460 & #5860. Gate boxes shall be identical to present City of Framingham Water Department requirements.
- B. 2-1/2 inch and Smaller: Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, extension box and valve key. Open right. Epoxy coated.
- C. 3 inch and Larger: AWWA C500, Iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, extension box and valve key. Open right. Epoxy coated.

## 2.6 BACKFLOW PREVENTERS

- A. Manufacturers: Any manufacturer whose product meets the requirements of the specifications, and the requirements of the City of Framingham Water Department, shall be considered.
- B. Furnish materials in accordance with MHD and MA DEP standards.

C. Reduced Pressure Backflow Preventers:

1. Comply with ASSE 1013.
2. Bronze body, with bronze internal parts and stainless steel springs.
3. Two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve opening under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

D. Double Check Valve Assemblies: Comply with ASSE 1012; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.

2.7 UNDERGROUND PIPE MARKERS

- A. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Water Service" in large letters.

2.8 BEDDING AND COVER MATERIALS

- A. Bedding: 1-1/2 inch stone in accordance with Section M2.01.1 of the MHD Standards
- B. Cover: 3/4 inch Crushed Stone in accordance with Section M2.01.4 of the MHD Standards
- C. Soil Backfill from Above Pipe to Finish Grade: Ordinary Fill as specified in Section 310000 - EARTHWORK.
- D. Bituminous Asphalt Patch: Refer to patching requirements under Section 321216 - ASPHALT PAVING.

2.9 JOINT RESTRAINT PRODUCTS

- A. Wedge Action Retaining Joints may be used wherever approved by the City of Framingham and shall be manufactured of ductile iron conforming to ASTM A536. The mechanical joint restraint shall be Megalug Series 1100 or equal approved by DPW.
- B. Concrete for Thrust Blocks: 4,000 psi concrete in accordance with Section M4.02.00 of the MHD Standards.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify building service connection and municipal utility water main size, location, and invert are as indicated on Drawings.

### 3.2 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.

### 3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 310000 - EARTHWORK for Work of this Section.
- B. Form and place concrete for pipe thrust restraints at change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide square footage of thrust restraint bearing on subsoil per detail.
- C. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 8 inch compacted depth; compact to 95 percent.
- D. Backfill around sides and to top of pipe in accordance with Section 310000 - EARTHWORK.
- E. Maintain optimum moisture content of fill material to attain required compaction density.
- F. Place fill materials in accordance with Section 310000 - EARTHWORK and Section 321216 - ASPHALT PAVING.

### 3.4 INSTALLATION - PIPE

- A. Maintain 10 foot horizontal separation of water piping from sewer piping, unless site constraints prohibit.
- B. Install pipe to indicated elevation to within tolerance of 5/8 inch.
- C. Route pipe in straight line.
- D. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- E. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.
- F. Establish elevations of buried piping with not less than 5.5 feet of cover. If cover is less than 5.5 feet, the pipe shall be insulated with 2 inches of extruded polystyrene insulation. The pipe shall maintain a minimum of 4 feet of cover.
- G. Install trace wire continuous over top of pipe.
- H. Backfill trench in accordance with Section 310000.

- I. Install Work in accordance with MHD and MA DEP standards.

### 3.5 UNDERGROUND PIPE MARKERS

- A. Manufacturers:
  1. Any manufacturers of such products shall be considered.
  2. Substitutions: Refer to Section 016000 - PRODUCT REQUIREMENTS.
- B. Plastic Ribbon Tape: Bright colored, imprinted with "WATER" in large letters, minimum 6 inches wide by 4 mil. thick, manufactured for direct burial service.
- C. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "WATER SERVICE" in large letters.

### 3.5 INSTALLATION - VALVES

- A. Set valves on compacted soil.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Install Work in accordance with MHD and MA DEP standards.

### 3.6 SERVICE CONNECTIONS

- A. Install water service in accordance with double check valve backflow preventer.
- B. Install water service to of building. Connect to building water service.
- C. Install Work in accordance with Mass State Plumbing Code.

### 3.7 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. CLOSEOUT SUBMITTALS
  1. Section 017700 - Closeout Procedures
  2. DISINFECTION REPORT:
    - a. Type and form of disinfectant used.
    - b. Date and time of disinfectant injection start and time of completion.
    - c. Test locations.
    - d. Name of person collecting samples.
    - e. Initial and 24 hour disinfectant residuals in treated water in ppm for each outlet tested.
    - f. Date and time of flushing start and completion. Disinfectant residual after flushing in ppm for each outlet tested.



3. Bacteriological REPORT:
    - a. Date issued, project name, and testing laboratory name, address, and telephone number.
    - b. Time and date of water sample collection.
    - c. Name of person collecting samples.
    - d. Test locations.
    - e. Initial and 24 hour disinfectant residuals in ppm. for each outlet tested.
    - f. Coliform bacteria test results for each outlet tested.
    - g. Certify water conforms, or fails to conform, to bacterial standards of MA DEP standards for drinking water.
    - h. Water Quality Certificate: Certify water conforms to quality standards of MA DEP, suitable for human consumption.
  
  4. QUALITY ASSURANCE
    - a. Perform Work in accordance with AWWA C651 (equivalent to State standards).
    - b. Maintain one copy of each document on site.
  
  5. QUALIFICATIONS
    - a. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this section with minimum three years documented experience.
    - b. Testing Firm: Company specializing in testing and examining potable water systems, approved by Commonwealth of Massachusetts.
    - c. Submit bacteriologist's signature and authority associated with testing.
  
  6. DISINFECTION CHEMICALS
    - a. Chemicals: Chlorine solution used for disinfecting springs, wells, and other water systems shall consist of a solution of water and liquid chlorine, sodium hypochlorite, calcium hypochlorite, or chloride of lime.
    - b. Liquid forms of chlorine or sodium hypochlorite and powder forms of calcium hypochlorite or chloride of lime shall be used according to the instructions supplied by the manufacturer and as recommended by the Massachusetts Department of Health.
    - c. If sodium hypochlorite is already in solution as a laundry bleach containing 5.25% sodium hypochlorite, it shall be used at the rate of one part per 12,000 parts of water to be disinfected. The dosage should be sufficient to produce a chlorine taste in the water.
  
  7. EXAMINATION
    - a. Verify existing conditions before starting work.
    - b. Verify piping system has been cleaned, inspected, and pressure tested.
    - c. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting and balancing, demonstration procedures, including coordination with related systems.
  
  8. INSTALLATION
-

- a. Provide and attach required equipment to perform the Work of this section.
  - b. Perform disinfection of water distribution system and installation of system and pressure testing.
  - c. Introduce treatment into piping system at a concentration of 50 mg Cl/L.
  - d. Maintain disinfectant in system for 24 hours.
  - e. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
  - f. Replace permanent system devices removed for disinfection.
9. Disinfection, FLUSHING, AND SAMPLING:
- a. Disinfect pipeline installation in accordance with AWWA C651. Use of liquid chlorine is not permitted
  - b. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
  - c. Legally dispose of chlorinated water. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.
  - d. After final flushing and before pipeline is connected to existing system, or placed in service, employ an approved independent testing laboratory to sample, test and certify water quality suitable for human consumption.

### 3.8 FIELD QUALITY CONTROL

- A. Sections 014000 - QUALITY REQUIREMENTS and 017700 - CLOSEOUT PROCEDURES.
- B. Pressure test system. Repair leaks and re-test.
  1. After completion of pipeline installation, including backfill, but prior to final connection to existing system, conduct, in presence of Architect/Engineer, concurrent hydrostatic pressure and leakage tests in accordance with AWWA C600.
  2. Provide equipment required to perform leakage and hydrostatic pressure tests.
  3. Test Pressure: Not less than 200 psi or 50 psi in excess of maximum static pressure, whichever is greater.
  4. Conduct hydrostatic test for at least two-hour duration.
  5. No pipeline installation will be approved when pressure varies by more than 5 psi at completion of hydrostatic pressure test.
  6. Before applying test pressure, completely expel air from section of piping under test. Provide corporation cocks so air can be expelled as pipeline is filled with water. After air has been expelled, close corporation cocks and apply test pressure. At conclusion of tests, remove corporation cocks removed and plug resulting piping openings.
  7. Slowly bring piping to test pressure and allow system to stabilize prior to conducting leakage test. Do not open or close valves at differential pressures above rated pressure.
  8. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damage or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.

- 9. When leakage is detected, locate source and make repairs. Repeat test until specified leakage requirements are met.
- C. Compaction Testing for Bedding: In accordance with ASTM D1557.
- D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- E. Frequency of Compaction Tests: As directed by Engineer.

END OF SECTION

SECTION 33 31 00

SANITARY UTILITY SEWERAGE PIPING

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
1. Install and test polyvinyl chloride (PVC) sewer pipe, complete as shown on the Drawings and as specified herein.
  2. Pipe or piping refers to all pipe, fittings, material and appurtenances required to construct PVC gravity and pressure sewer pipe complete, in place.
- B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. Section 310000 - EARTH MOVING: Soil for backfill in trenches.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials:
1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10 lb. Rammer and an 18 in. Drop.
- B. ASTM International:
1. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Rigid Poly (Vinyl Chloride) (CPVC) Compounds
  2. ASTM D1785 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
  3. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
  4. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
  5. ASTM D2466 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
  6. ASTM D2564 - Standard Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems.

7. ASTM D2729 - Standard Specification for Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
8. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
9. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
10. ASTM D3034 - Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
11. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals
12. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
13. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
14. ASTM F789 - Standard Specification of Type PS-46 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings.

#### 1.4 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

#### 1.5 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data indicating pipe material used, pipe accessories, and fittings.
- C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Section 017700 - CLOSEOUT PROCEDURES.
- B. Project Record Documents: Record location of pipe runs, connections, manholes, cleanouts, and invert in and invert out elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

#### 1.7 QUALITY ASSURANCE

- A. All PVC sewer pipe shall be from a single manufacturer. The supplier shall be responsible for the provision of all test requirements specified in ASTM D3034 or ASTM F789 as applicable. In addition, all PVC pipe to be installed under this Contract may be

inspected at the plant for compliance with these Specifications by an independent testing laboratory provided by the Owner. The Contractor shall require the manufacturer's cooperation in these inspections. The cost of plant inspection of all pipe approved for this Contractor, plus the cost of inspection of a reasonable amount of disapproved pipe, will be borne by the Owner.

- B. Inspections of the pipe may also be made by the Engineer or other representatives of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though the sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. All items shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Engineer.
- B. PVC items deteriorate in sunlight and are slightly brittle, especially at lower temperatures, so care shall be taken in loading, transporting, and unloading items to prevent damage to the items. All items shall be examined before installation and no piece shall be installed which is found to be defective. Handling and installation of pipe and fittings shall be in accordance with the manufacturer's instructions, references standards, and as specified herein.
- C. Any pipe or fitting showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work site.
- D. While stored, pipe shall be adequately supported from below at not more than 3 foot intervals to prevent deformation. The pipe shall not be stacked higher than 6 feet.
- E. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of the sunlight. Temporary shading to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup or direct or indirect sunlight shall not be permitted.
- F. If any defective item is discovered after it has been installed, it shall be removed and replaced with an exact replacement item in a satisfactory manner by the Contractor, at the Contractor's own expense. All pipe and fittings shall be thoroughly cleaned before installation and the interior shall be kept clean until testing.
- G. In handling the items, use special devices and methods as to achieve the results specified herein. No un-cushioned devices shall be used in handling the item.

#### 1.9 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this section.

1.10 FIELD MEASUREMENT

- A. Verify field measurements and elevations are as indicated.

1.11 COORDINATION

- A. Coordinate the Work with abandonment of existing septic tanks and associated piping, and abandonment of existing leaching fields.

PART 2 - PRODUCTS

2.1 SANITARY SEWAGE GRAVITY PIPE

- A. Plastic Pipe: ASTM D3034, Type PSM, SDR 35, Poly Vinyl Chloride (PVC) material; inside nominal diameter of 8 in., bell and spigot style rubber ring sealed gasket joint.
  - 1. Fittings: PVC.
  - 2. Push On Joints: ASTM F477, elastomeric gaskets per ASTM D3212, securely locked into place to prevent displacement during assembly.
  - 3. All fittings and accessories for sewer shall have bell and/or spigot configurations compatible with the pipe.

2.2 UNDERGROUND PIPE MARKERS

- A. Manufacturers:
  - 1. Any manufacturers of such products shall be considered.
  - 2. Substitutions: Refer to Section 016000 - PRODUCT REQUIREMENTS.
- B. Plastic Ribbon Tape: Bright colored, imprinted with "Sewer Line" in large letters, minimum 6 inches wide by 4 mil. thick, manufactured for direct burial service.

2.3 MANHOLES

- A. In accordance with Section 330513 - MANHOLES AND STRUCTURES

2.4 BEDDING AND COVER MATERIALS

- A. Bedding and Cover: 3/4 inch crushed stone in accordance with Section M2.01.4 of the MHD Standard Specifications.
- B. Soil Backfill from Above Pipe: In pavement areas where controlled density fill is not specified, provide Ordinary Fill to the sub-base of the pavement, and then provide the required sub-base material for the pavement section. In grassed areas where controlled density fill is not specified, provide Special Borrow per MassDOT Spec.

M1.02.0 to a point 6 inches below finished grade, then Manufactured Topsoil to finished grade.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on the Drawings.

#### 3.2 PREPARATION

- A. Correct over excavation with coarse aggregate.
- B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

#### 3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 310000 - EARTHWORK.
- B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches.
- C. Maintain optimum moisture content of bedding material to attain required compaction density.

#### 3.4 INSTALLATION OF PVC PIPE AND FITTINGS

- A. No single piece of pipe shall be laid unless it is straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the opening at the ends of the pipe by more than 1/16 inch per foot of length. If a piece of pipe fails to meet this required check for straightness, it shall be rejected and removed from the site. Laying instructions of the pipe shall be explicitly followed.
- B. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work, and when laid shall conform to the lines and grades required. PVC pipe and fittings shall be installed in accordance with requirements of the manufacturer, ASTM D2321 or as otherwise provided herein.
- C. As soon as the excavation is complete to normal grade of the bottom of the trench, bedding shall be placed, compacted, and graded to provide firm, uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of



the pipe bears upon the bedding. The pipe shall be laid accurately to the lines and grades indicated on the Drawings. Blocking under the pipe shall not be permitted. Bedding shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the bedding under the haunches of the pipe and into the bell holes to give firm, continuous support for the pipe. The initial 3 feet of backfill above the bedding shall be placed in 1 foot layers and carefully compacted, where controlled density fill is not specified. Generally, the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compacting the initial 3 feet of backfill shall be approved by the pipe manufacturer prior to use.

- D. All pipe shall be sound and clean before installation. When installation is not in progress, including lunchtime, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved during installation. The deflection at joints shall not exceed that recommended by the manufacturer. Fittings, in addition to those shown on the plans, shall be provided, if required, in crossing utilities which may be encountered upon opening the trench.
- E. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of the pipe to be used with a bell shall be beveled to the manufactured spigot end.
- F. The Engineer may examine each bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such and immediately removed from the job site.
- G. Each length of the pipe shall have the assembly mark aligned with the pipe previously laid and held securely until enough backfill has been placed to hold the pipe in place. Joints shall not be 'pulled' or 'cramped.'
- H. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.
- I. Precautions shall be taken to prevent flotation of the pipe in the trench.
- J. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below the top of the pipe. If trench boxes, moveable sheeting, shoring or plates have been installed below the top of the pipe, they shall be moved slowly taking care not to disturb pipe, bedding, or backfill. As trench boxes, moveable sheeting, shoring or plates are moved, pipe bedding shall be placed to fill any voids created and the backfill shall be re-compacted to provide uniform side support for the pipe.

### 3.5 JOINTING PVC PIPE (PUSH ON TYPE)

- A. Joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead (upgradient of the spigot end). A rubber

gasket shall be inserted in the groove of the belled end and the joint surfaces cleaned and lubricated. The plain edge of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which is it to be jointed and pushed home with a come-along or by other means. Check that the reference mark on the spigot is flush with the end of the bell.

### 3.6 JOINTING PVC SEWER PIPE AND FITTINGS

- A. PVC sewer pipe and fittings shall be jointed in accordance with the recommendations of the latest ASTM standards and detailed instructions of the manufacturer. The pipe manufacturer shall furnish information and supervise the installation of at least the first five joints.
- B. All manhole connections shall be as shown on the Drawings except that concrete and mortared connections shall be equipped with an integral o-ring or other sealant such that a positive watertight seal is established.

### 3.7 SERVICE CONNECTIONS

- A. Service connections shall be installed at a minimum slope of 2% at the locations and to the limits determined by the Engineer in the field. In each case the end shall be capped, backed with a #2 reinforcing rod welded to a 6 inch x 6-1/4 inch steel plate extending to 6 inches below the finished ground surface as shown on the Drawings.
- B. Service connections shall be 8 in. diameter PVC unless otherwise shown on the Drawings.
- C. Service connections shall be made at a point 10 feet outside the foundation of the building in accordance with the Uniform Plumbing Code. If the existing building surface is in structurally deficient condition or constructed of a material not approved by the plumbing inspector, the Contractor shall stop work immediately and contact the Engineer.

### 3.8 INSTALLATION - MANHOLES

- A. In accordance with Section 330513 – MANHOLES AND STRUCTURES

### 3.9 FIELD QUALITY CONTROL

- A. Refer to Sections 014000 - QUALITY REQUIREMENTS, 017300 - EXECUTION REQUIREMENTS, and 017700 - CLOSEOUT PROCEDURES.
- B. Perform test on site sanitary sewage system in accordance with municipal standards.
- C. Request inspection by Engineer prior to and immediately after placing bedding and piping. Provide minimum 24 hours notice. The Board of Health will inspect all work prior to issuing its approval. The Board of Health shall be given a minimum of 24 hours

advance notice when requesting an inspection. The Contractor shall comply with all inspection requirements of the Town of Framingham.

- D. Compaction Testing: In accordance with ASTM D1557.
- E. When tests indicate Work does not meet specified requirements, remove work, replace and retest.
- F. Frequency of Compaction Tests: As directed by Engineer.

### 3.10 PROTECTION OF FINISHED WORK

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

### 3.11 TESTING (GRAVITY PIPELINES)

- A. Deflection testing of pipe shall be specified as follows:
  - 1. Pipe deflection measured not less than 90 days after the backfill has been completed as specified shall not exceed 5%. Deflection shall be computed by multiplying the amount of deflection (nominal diameter less minimum diameter when measured) by 100 and dividing by the nominal diameter of the pipe.
  - 2. Deflection shall be measured by a rigid mandrel (Go/No Go) device cylindrical in shape with a minimum of nine or ten evenly spaced arms or prongs. Drawings of the mandrel with complete dimensions shall be submitted to the Engineer for each diameter of pipe to be tested. The mandrel shall be hand pulled through all sewer lines.
  - 3. Any section of sewer not passing the mandrel shall be uncovered at no additional cost to the Owner and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested at no additional cost to the Owner. Retested pipe shall not deflect more than 5%.
- B. Low pressure air testing of pipe shall be specified as follows:
  - 1. For making the low-pressure air tests, use equipment specifically designed and manufactured for the purpose of testing sewer pipelines using low-pressure air. The equipment shall be provided with an air regulator valve or air safety so set that the internal air pressure in the pipeline cannot exceed 8 psig.
  - 2. The leakage test using low pressure air shall be made on each manhole-to-manhole section of pipelines after placement of the backfill.
  - 3. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.
  - 4. All air used shall pass through a single control panel.
  - 5. Low-pressure air shall be introduced into the sealed line until the internal air pressure reaches 4 psig greater than the minimum pressure exerted by the groundwater that may be above the invert at the pipe at the time of the test. However, the internal air pressure in the sealed line shall not be allowed to

exceed 8 psig. When the maximum pressure exerted by the groundwater is greater than 4 psig, conduct only an infiltration test, as specified below.

6. Testing shall be in accordance with the requirements of ASTM F1417-92. The following italicized text contains selected text from ASTM F1417 (Gravity Sewer Lines).
  - *The section of the line to be tested is plugged. Air, at low pressure, is introduced into the plugged line. The line passes the test if the rate of air loss, as measured by pressure drop, does not exceed a specified amount in a specified time.*
  - *Pressure drop may be determined by using Table 1 or calculated by use of the formulas below.*

**TABLE 1: MINIMUM SPECIFIED TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015 (NOTE-CONSULT WITH PIPE AND APPURTENANCE MANUFACTURER FOR MAXIMUM TEST PRESSURE FOR PIPE SIZE GREATER THAN 30 IN. IN DIAMETER.)**

Pipe Diameter	Minimum Time, min:sec	Length for Min. Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s							
				100	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	0.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	28:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:2	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:2	21:38	28:51	36:04	43:18	50:30	57:42	64:54
30	14:10	80	10.683 L	17:4	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	21:3	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	25:3	38:28	51:17	64:06	76:55	89:44	102:3	115.2

- *Calculate all test times by the following formula:  $T = 0.085 DK/Q$ , where:  $T$  = shortest time allowed for the air pressure to drop 1.0 psig,  $K = 0.000419$  DL but not less than 1.0,  $Q$  = leak rate in cubic feet/minute/square feet of internal surface = 0.0015 CFM/SF,  $D$  = measured average inside diameter of sewer pipe (see Method D 2122 and Practice D 3567), in., and  $L$  = length of test section, ft.*

- *Table 1 contains the specified minimum times required for a 1.00 psig pressure drop from a starting pressure of 3.5 psig to a final pressure of 2.5 psig using a leakage rate of 0.0015 ft<sup>3</sup>/min/ft<sup>2</sup> of internal surface.*
- C. Infiltration testing of pipe shall only be carried out when the depth of groundwater is so great that low pressure air testing cannot be adequately performed; otherwise low pressure air testing shall be performed as specified above. The procedure for infiltration testing of pipe is as follows:
1. For making the infiltration tests, underdrains, if used, shall be plugged and other groundwater drainage shall be stopped to permit groundwater to return to its normal level insofar as practicable.
  2. Upon completion of a section of the sewer, dewater it and conduct a satisfactory test to measure the infiltration for at least 24 hours. The amount of infiltration, including manholes, tees, and connections, shall not exceed 200 gallons per inch diameter per mile of sewer per 24 hours.

END OF SECTION

SECTION 33 41 00  
STORM UTILITY DRAINAGE PIPING

**PART 1 - GENERAL**

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.
- B. The General Contractor shall either perform the work of this section with its own forces or shall subcontract such work to a subcontractor who will furnish a performance and payment bond for the complete scope of work and listing the Owner as the co-obligee. Such bond shall be procured from a surety that is currently licensed to do business in Massachusetts and is currently listed on the United States Treasury Department circular 570. A copy of such bond shall be submitted to the Owner's Project Manager for approval and shall be in place prior to the subcontractor commencing any work on the project.

1.2 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to install high density polyethylene pipe, fittings and appurtenances as indicated and as specified herein.

1.3 RELATED WORK

- A. Section 310000 - EARTH MOVING
- B. Section 330513 - MANHOLES AND STRUCTURES

1.4 SUBMITTALS

- A. Submit the name of the pipe and fitting suppliers and Shop Drawings, showing layout details of reinforcement, joint, method of manufacture, and installation of pipe, specials, and fittings for the entire job.
- B. Prior to each shipment of pipe submit certified test reports and a notarized affidavit stating that all pipe meets requirements of ASTM D1238 & ASTM D1505.

1.5 REFERENCED STANDARDS

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM D1238 - Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.

2. ASTM D1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
  3. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
  4. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
  5. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
  6. ASTM D3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Materials
  7. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe and (SDR-PR) Based on Outside Diameter.
- B. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.

## **PART 2 - PRODUCTS**

### **2.1 HIGH DENSITY POLYETHYLENE (HDPE) PIPE – SINGLE PIPE SYSTEM**

- A. High Density Polyethylene (HDPE) Pipe resins shall be high molecular weight, high density polyethylene with a cell classification number of 424420C in accordance with ASTM D3350.
- B. HDPE shall have a smooth interior and annular exterior corrugations, 12 inch through 60 inch piping shall meet ASTM F2648 and shall be either AASHTO Type 'S' or Type 'D'.
- C. Pipe shall be joined using a bell & spigot joint meeting ASTM F2648. The joint shall be soil-tight and gaskets, when applicable, shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.
- D. Pipe shall support an HS-20 live load with a maximum deflection of 5% of the minimum pipe diameter.
- E. Pipe shall be furnished in standard laying lengths not exceeding 25 feet.
- F. All single pipe high density polyethylene pipe and fittings shall be made from the same resin.
- G. Pipe shall comply with the requirements for test methods, dimensions and markings found in AASHTO Designations M252 and M294.

### **2.2 CONCRETE PIPE AND FITTINGS**

- A. Reinforced-Concrete sewer pipe and fittings shall be ASTM C76 or ASTM C655.
  1. Bell-and-spigot ends and rubber gasketed joints with ASTM C443.
  2. Class III pipe shall be used for typical installations.

3. Class V pipe shall be used where cover is 2 ft. or less, where indicated on the plans, or where recommended by the manufacturers.

#### 2.3 POLYVINYL CHLORIDE (PVC):

- A. Pipe and Fittings, Type PSM PVC Pipe, shall conform to ASTM D3034, Type PSM, SDR 35. Pipe and fittings shall have elastomeric gasket joints providing a watertight seal when tested in accordance with ASTM D 3212. Gaskets shall conform to ASTM F 477. Solvent welded joints shall not be permitted.
- B. Use for underdrains only.

#### 2.4 UNDERGROUND PIPE MARKERS

- A. Manufacturers:
  1. Any manufacturers of such products shall be considered.
  2. Substitutions: Refer to Section 016000 - PRODUCT REQUIREMENTS.
- B. Plastic Ribbon Tape: Bright colored, imprinted with "Storm Drain Line" in large letters, minimum 6 inches wide by 4 mil. thick, manufactured for direct burial service.

#### 2.5 PIPE IDENTIFICATION

- A. The following shall be continuously indent printed on the pipe and spaced at intervals not exceeding 5 feet.
  1. Name and/or trademark of the pipe manufacturer.
  2. Nominal pipe size.
  3. Dimension ratio.
  4. The letters PE followed by the polyethylene grade in accordance with ASTM D1248, followed by the hydrostatic design basis in 100's of psi., e.g., PE 3408.
  5. Manufacturing standard reference, e.g., ASTM F714.
  6. A production code from which the date and place of manufacture can be determined.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION - PIPE

- A. High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the instruction of the manufacturer, as indicated and as specified herein.
- B. Polyvinyl Chloride (PVC) Pipe shall be installed in accordance with the instruction of the manufacturer, as indicated and as specified herein.
- B. Pipe shall be laid to lines and grade as indicated with bedding and backfill as indicated.
- C. When laying is not in progress, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means. All plugs shall be OD fitting type plugs. No plugs will be allowed that require insertion of the plug into the pipe.



- D. Pipe shall be stored on clean level ground to prevent scratching or gouging. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches, or gouges on the exterior of the pipe is 10 percent of the wall thickness. The interior pipe surface shall be free of cuts, gouges, or scratches.
- E. Sections of pipe with cuts, scratches, or gouges deeper than allowed shall be removed completely and replaced and the ends of the pipeline rejoined at no additional cost to the City of Framingham.
- F. Single pipe systems shall be jointed by the method of thermal butt fusion, as outlined in ASTM D2657. All joints shall be made in strict compliance with the manufacturer's recommendations.
- G. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.

### 3.2 TESTING

- A. HDPE storm drain pipe installations shall be mandrel tested to ensure that the pipe has maintained a circular shape in cross section throughout installation. The pipe shall remain within 5% of a true circular shape. Pipe deflection beyond 5% shall be repaired by reinstallation.

### 3.3 CLEAN UP

- A. Prior to Final Completion of the Work, thoroughly clean all the new pipelines and remove all dirt, stones, and pieces of wood or other materials.

END OF SECTION

## SECTION 33 49 23

### STORM DRAINAGE RETENTION STRUCTURES

#### PART 1 GENERAL

##### 1.01 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.
- B. The General Contractor shall either perform the work of this section with its own forces or shall subcontract such work to a subcontractor who will furnish a performance and payment bond for the complete scope of work and listing the Owner as the co-obligee. Such bond shall be procured from a surety that is currently licensed to do business in Massachusetts and is currently listed on the United States Treasury Department circular 570. A copy of such bond shall be submitted to the Owner's Project Manager for approval and shall be in place prior to the subcontractor commencing any work on the project.

##### 1.02 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to install high density polyethylene groundwater recharge chambers, fittings, manifolds, and appurtenances as indicated and as specified herein.

##### 1.03 RELATED WORK

- A. Section 31 00 00, EARTHWORK
- B. Section 33 05 13, MANHOLES AND STRUCTURES
- C. Section 33 41 00, STORM UTILITY DRAINAGE PIPING.

##### 1.04 SUBMITTALS

- A. Submit the name of the recharge unit and fitting suppliers and Shop Drawings, showing layout details of reinforcement, joint, method of manufacture, and installation of recharge units, specials, and fittings for the entire job.
- B. Prior to each shipment of recharge units submit certified test reports and a notarized affidavit stating that all recharge units meet requirements of ASTM D1238 & ASTM D1505.

##### 1.05 REFERENCED STANDARDS

- A. American Society for Testing and Materials (ASTM)
  - 1. ASTM D1238 – Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
  - 2. ASTM D1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
  - 3. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

4. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Recharge units and Fittings.
  5. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Recharge units Materials.
  6. ASTM D3350 - Standard Specification for Polyethylene Plastic Recharge units and Fittings Materials
  7. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Recharge units and (SDR-PR) Based on Outside Diameter.
- B. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.

## PART 2 PRODUCTS

### 2.01 HIGH DENSITY POLYETHYLENE RECHARGE UNITS

- A. High Density Polyethylene (HDPE) recharge unit resins shall be high molecular weight, high density polyethylene with a cell classification number of 345434C in accordance with ASTM D3350.
- B. All polyethylene recharge units shall meet the requirements of ASTM F714.
- C. The recharge units shall be jointed with, butt head fusion joints. All joints shall be made in strict compliance with the manufacture's recommendations.
- D. Recharge units shall be furnished in standard laying lengths not exceeding 25 ft.
- E. All high density polyethylene recharge units and fittings shall be made from the same resin.

### 2.02 RECHARGE UNITS IDENTIFICATION

- A. The following shall be continuously indent printed on the recharge units.
1. Name and/or trademark of the recharge unit manufacturer.
  2. Nominal size.
  3. Dimension ratio.
  4. The letters PE followed by the polyethylene grade in accordance with ASTM D1248, followed by the hydrostatic design basis in 100's of psi, e.g., PE 3408.
  5. Manufacturing standard reference, e.g., ASTM F714.
  6. A production code from which the date and place of manufacture can be determined.

### 2.03 CHAMBER PARAMETERS

- A. The chamber will be vacuum thermoformed of high molecular weight high density polyethylene (HMWHDPE).
- B. The chamber will be arched in shape.
- C. The chamber will be open-bottomed.

- D. The chamber will be joined using an interlocking overlapping rib method. Connections must be fully shouldered overlapping ribs, having no separate couplings or separate end walls.
- E. The nominal chamber dimensions of the recharge units shall be capable of storing the required volume for recharge in the area at the depths noted on the plans.
- F. The chambers shall be fitted with either an external or an internal manifold to evenly distribute the stormwater. If internal manifolds are used the chambers will have two side portals to accept feed connectors for the internal manifold.
- G. The nominal dimensions of each internal manifold side portal will be manufacturer's specifications.
- H. The nominal chamber dimensions of an external manifold will be per manufacturer's recommendations.
- I. The chambers will have discharge holes bored into the sidewalls of the unit's core to promote lateral conveyance of water.
- J. The endwall of the chamber, when present, will be an integral part of the continuously formed unit.
- K. The starter unit must be formed as a whole chamber having one fully formed integral endwall and one partially formed integral endwall.
- L. The intermediate unit must be formed as a whole chamber having one fully open endwall and one partially formed integral endwall.
- M. The end unit must be formed as a whole chamber having one fully formed integral endwall and one fully open end wall and having no separate end plates or end walls.
- N. Internal manifold feed connectors must be formed as a whole chamber having two open end walls and having no separate end plates or separate end walls. The unit will fit into the side portals of the chamber and act as cross feed connections.
- O. Chambers must have horizontal stiffening flex reduction steps between the ribs.
- P. The chamber will be designed to withstand AASHTO H-25 load rating when installed according to manufacturer's recommended installation instructions.
- Q. Heavy duty units are designated by a colored stripe formed into the part along the length of the chamber.
- R. The chamber will have a raised integral cap at the top of the arch in the center of each unit to be used as an optional inspection port or clean out.
- S. The units may be trimmed to custom lengths by cutting back to any corrugation on the large rib end.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. High Density Polyethylene (HDPE) recharge units shall be installed in accordance with the instruction of the manufacturer, as indicated and as specified herein.
- B. Recharge units shall be laid to lines and grade as indicated with bedding and backfill as indicated.
- C. When laying is not in progress, the open ends of the recharge units shall be closed by fabricated plugs, or by other approved means. All plugs shall be OD fitting type plugs. No plugs will be allowed that require insertion of the plug into the recharge units.
- D. Recharge units shall be stored on clean level ground to prevent scratching or gouging. The handling of the recharge units shall be in such a manner that the recharge units is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches, or gouges on the exterior of the recharge units is 10 percent of the wall thickness. The interior of the recharge unit surfaces shall be free of cuts, gouges, or scratches.
- E. Sections of recharge units with cuts, scratches, or gouges deeper than allowed shall be removed completely and replaced and the ends of the recharge units rejoined at no additional cost.
- F. Single recharge units systems shall be jointed by the method of thermal butt fusion, as outlined in ASTM D2657. All joints shall be made in strict compliance with the manufacturer's recommendations.
- G. All HDPE recharge units must be at the temperature of the surrounding soil at the time of backfilling and compaction.

### 3.02 INSTALLATION

- A. Installing contractors are expected to comprehend and use the most current installation instructions prior to beginning a system installation.
- B. Contact manufacturer at least thirty days prior to system installation to arrange for a pre-construction meeting.
- C. All system designs must be certified by a registered professional engineer licensed in the Commonwealth of Massachusetts.
- D. Use these installation instructions as a guideline only. Actual design may vary. Refer to approved construction drawings for job-specific details. Be sure to follow the engineer's drawings as your primary guide.
- E. System cover/backfill requirements will vary based on chamber model. Please refer to Engineer's drawings.
- F. Any discrepancies with the system sub-grade soil's bearing capacity must be reported to the Engineer.
- G. Filter fabric must be used as specified in the Contract drawings.
- H. Manufacturer requires the contractor to refer to the manufacturer's installation instructions, concerning vehicular traffic. Responsibility for preventing vehicles that

exceed the manufacturer's requirements from traveling across or parking over the chamber system lies solely with the contractor throughout the entire site construction process.

- I. The placement of warning tape, temporary fencing, and/or appropriately located signs is required. Acceptable vehicle loading criteria is HS-20 loading.

- J. UNDERGROUND PIPE MARKERS

Manufacturers:

1. Any manufacturers of such products shall be considered.
2. Substitutions: Refer to Section 01 60 00 - Product Requirements.
3. Plastic Ribbon Tape: Bright colored, imprinted with "STORM" in large letters, minimum 6 in. wide by 4 mil. thick, manufactured for direct burial service.
4. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "STORM" in large letters.

- K. Erosion and sediment-control measures must meet state and local codes and the design engineer's specifications throughout the entire site construction process.

- L. Underground recharge systems must be designed and installed in accordance with the manufacturer's minimum requirements.

### 3.03 CLEANING

- A. Prior to Final Completion of the Work, thoroughly clean all the new recharge units and remove all dirt, stones, and pieces of wood or other materials.

END OF SECTION

# **APPENDIX A**

# **LEED SCORECARD**



**LEED v4 for BD+C: Schools**  
Project Checklist

Project Name: Fuller Middle School  
Date: 08/06/2019



Y ? N

Y	1	Credit	Integrative Process	1
<b>4</b>	<b>1</b>	<b>10</b>	<b>Location and Transportation</b>	<b>15</b>
	X	Credit	LEED for Neighborhood Development Location	15
1		Credit	Sensitive Land Protection	1
1	1	Credit	High Priority Site	2
2	3	Credit	Surrounding Density and Diverse Uses	5
	4	Credit	Access to Quality Transit	4
	1	Credit	Bicycle Facilities	1
	1	Credit	Reduced Parking Footprint	1
1		Credit	Green Vehicles	1
<b>5</b>	<b>2</b>	<b>5</b>	<b>Sustainable Sites</b>	<b>12</b>
Y		Prereq	Construction Activity Pollution Prevention	Required
Y		Prereq	Environmental Site Assessment	Required
1		Credit	Site Assessment	1
	2	Credit	Site Development - Protect or Restore Habitat	2
1		Credit	Open Space	1
1	2	Credit	Rainwater Management	3
	2	Credit	Heat Island Reduction	2
1		Credit	Light Pollution Reduction	1
	1	Credit	Site Master Plan	1
1		Credit	Joint Use of Facilities	1
<b>5</b>	<b>0</b>	<b>7</b>	<b>Water Efficiency</b>	<b>12</b>
Y		Prereq	Outdoor Water Use Reduction	Required
Y		Prereq	Indoor Water Use Reduction	Required
Y		Prereq	Building-Level Water Metering	Required
1	1	Credit	Outdoor Water Use Reduction	2
3	4	Credit	Indoor Water Use Reduction	7
	2	Credit	Cooling Tower Water Use	2
1		Credit	Water Metering	1
<b>17</b>	<b>8</b>	<b>6</b>	<b>Energy and Atmosphere</b>	<b>31</b>
Y		Prereq	Fundamental Commissioning and Verification	Required
Y		Prereq	Minimum Energy Performance	Required
Y		Prereq	Building-Level Energy Metering	Required
Y		Prereq	Fundamental Refrigerant Management	Required
5	1	Credit	Enhanced Commissioning	6
12	4	Credit	Optimize Energy Performance	16
	1	Credit	Advanced Energy Metering	1
	2	Credit	Demand Response	2
1	2	Credit	Renewable Energy Production	3
1		Credit	Enhanced Refrigerant Management	1
2		Credit	Green Power and Carbon Offsets	2

<b>4</b>	<b>0</b>	<b>9</b>	<b>Materials and Resources</b>	<b>13</b>
Y		Prereq	Storage and Collection of Recyclables	Required
Y		Prereq	Construction and Demolition Waste Management Planning	Required
	5	Credit	Building Life-Cycle Impact Reduction	5
1	1	Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
	2	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
1	1	Credit	Building Product Disclosure and Optimization - Material Ingredients	2
2		Credit	Construction and Demolition Waste Management	2

<b>7</b>	<b>7</b>	<b>2</b>	<b>Indoor Environmental Quality</b>	<b>16</b>
Y		Prereq	Minimum Indoor Air Quality Performance	Required
Y		Prereq	Environmental Tobacco Smoke Control	Required
Y		Prereq	Minimum Acoustic Performance	Required
2		Credit	Enhanced Indoor Air Quality Strategies	2
2	1	Credit	Low-Emitting Materials	3
1		Credit	Construction Indoor Air Quality Management Plan	1
1	1	Credit	Indoor Air Quality Assessment	2
	1	Credit	Thermal Comfort	1
1	1	Credit	Interior Lighting	2
	3	Credit	Daylight	3
	1	Credit	Quality Views	1
	1	Credit	Acoustic Performance	1

<b>5</b>	<b>1</b>	<b>0</b>	<b>Innovation</b>	<b>6</b>
4	1	Credit	Innovation	5
1		Credit	LEED Accredited Professional	1

<b>1</b>	<b>1</b>	<b>2</b>	<b>Regional Priority</b>	<b>4</b>
1		Credit	Regional Priority: EAc2 Optimize Energy Performance (20%/8 pts)	1
	1	Credit	Regional Priority: EAc5 Renewable Energy Production (5%/2 pts)	1
	1	Credit	Regional Priority: LTc4 / LTc5	1
	1	Credit	Regional Priority: SSc2 / MRc1	1

**48** **20** **42** **TOTALS** Possible Points: **110**  
 Certified: 40 to 49 points, Silver: 50 to 59 points, Gold: 60 to 79 points, Platinum: 80 to 110



**APPENDIX B**

**CODE REPORT**

# Fire Protection and Life Safety Code Compliance Strategy

## FRAMINGHAM FULLER MIDDLE SCHOOL FRAMINGHAM, MA

Prepared For:



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**SUBMITTED: AUGUST 9, 2019**

**60% Construction Documents**

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**DOCUMENT HISTORY**

50% Schematic Design Fire Protection and Life Safety Code Compliance Strategy ..... August 8, 2018  
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 50% Construction Document Fire Protection and Life Safety Code Compliance Strategy ..... July 8, 2019  
 60% Construction Document Fire Protection and Life Safety Code Compliance Strategy ..... August 9, 2019

This document “Concept Design Fire Protection and Life Safety Code Compliance Strategy” is intended for use by the design team and code officials for understanding the building design concept for the proposed Framingham Fuller Middle School located in Framingham, MA. This document contains the code basis for the building design, functionality of the egress system, fire protection recommendations, the smoke control system design concept, and a comprehensive code outline.

This document is a preliminary draft based on the schematic building plans from Jonathan Levi Architects dated August 9, 2019. This document is a work in progress, will be updated as the design progresses and discussions/agreements with the Authorities Having Jurisdiction occur.

**PURPOSE**

The purpose of this report is to document and provide the code compliance strategy, including the framework for the fire protection and life safety concept, for the Framingham Fuller Middle School in Framingham, MA. This document will also identify design concepts that are not clearly addressed by the applicable building codes, which will require approval and or interpretation by the authorities having jurisdiction (AHJ).

**APPLICABLE CODES AND REQUIREMENTS**

The following codes are presently adopted in the State of Massachusetts:

- **Building**                    Massachusetts State Building Code (MSBC), 9<sup>th</sup> Edition, which adopts and amends the 2015 International Building Code and the 2015 International Existing Building Code (IEBC).
- **Accessibility**                Massachusetts Architectural Access Board (MAAB), 521-CMR.  
2010 ADA Standards for Accessible Design
- **Electrical**                    Massachusetts Electrical Code, 527 CMR, 12.00. The Massachusetts Electrical Code is an amended version of the 2017 National Electrical Code (NFPA 70).
- **Elevators**                    Massachusetts Elevator Regulations, 524-CMR.
- **Energy**                        2015 Edition of the International Energy Conservation Code (IECC) as amended by the State of Massachusetts; Massachusetts Stretch Code
- **Fire Prevention**            527 CMR Massachusetts Fire Prevention Code, which adopts and amends the 2015 edition of NFPA 1.
- **Mechanical**                International Mechanical Code, 2015 edition, as adopted and amended by the MSBC (Chapter 28).
- **Plumbing**                    Massachusetts Fuel Gas and Plumbing Codes (248 CMR).
- **Other**                         National Fire Protection Association (NFPA) Standards, as referenced by the MSBC and the MFPR.

## **PROJECT DESCRIPTION**

Howe Engineers has prepared this document for the Framingham Fuller Middle School located in Framingham, MA. The proposed building will be a newly constructed, three (3) story building with a footprint area of approximately 64,780 square feet. The building contains primarily Group E Educational spaces for middle school students (6<sup>th</sup> to 8<sup>th</sup> grade), with accessory office and lounge spaces. There is a gymnasium and auditorium on the north side of the building that will be considered Group A-3 assembly spaces as public events will likely be held in these spaces.

This narrative addresses the requirements contained in the 9th edition of 780 CMR, The Massachusetts State Building Code (MSBC), which is an amended version of the 2015 International Building Code (IBC).

## **GENERAL OPERATING ASSUMPTIONS**

The following general operating assumptions serve as the basis for the Life Safety and Fire Protection design and should be incorporated into the new facilities operations plan. It is the responsibility of the Owner/Operator to ensure that these assumptions are enforced:

- The materials used shall meet the interior finish requirements of the International Building, and NFPA 1.
- Hazardous materials and explosives are not permitted within the Building unless protected in accordance with the International Building and Fire Codes and approved by the Authority Having Jurisdiction.

**NEW CONSTRUCTION- CODE COMPLIANCE APPROACH**

***OCCUPANCY CLASSIFICATION***

The proposed Fuller School is classified as Mixed Use, containing Educational, Group E Occupancies, along with Assembly Group A and Business Group B Occupancies. The building serves as an educational building for students from the 6<sup>th</sup> through 8<sup>th</sup> grade containing primarily classroom spaces. There is a gymnasium and auditorium on the north side of the building which will likely hold events for the general public. As these spaces will hold events for the public, they must be considered Assembly spaces as they will accommodate occupants other than the students of the Fuller School. The occupancies in the building on the respective levels are as follows:

<b>First Floor (Level of Exit Discharge)</b>	<b>USE GROUP</b>
Classrooms / Lab Spaces	E
Gymnasium	A-4
Auditorium / Lounge Space	A-3
Office / Administration	B
Storage	S-1
MEP	S-2
<b>Second Floor</b>	<b>USE GROUP</b>
Classrooms	E
Office / Administration	B
Lounge / Breakout Space	A-3
Storage	S-1
MEP	S-2
<b>Third Floor</b>	<b>USE GROUP</b>
Classrooms	E
Office / Administration	B
Lounge / Breakout Space	A-3
Storage	S-1
MEP	S-2

***OCCUPANCY SEPARATIONS***

The Building contains a number of different occupancies, not included in the same occupancy group, within the building and is classified as Mixed-Use Occupancy in accordance with MSBC Section 508.1. Therefore, the building is required to comply with the requirements of either Section 508.3 (non-separated uses) or Section 508.4 (separated uses), or combinations of these sections. As the gymnasium, auditorium, and cafeteria on the first floor of the building will be used for public events, they must be considered assembly spaces. A nonseparated, mixed-use approach will be used for the design of the building to limit the required rated separations between occupancies. Refer to the Building Construction section below for minimum construction type necessary to allow for the application of the nonseparated mixed-use provisions.

## **BUILDING CONSTRUCTION**

### ***CONSTRUCTION TYPE***

The Framingham Fuller School will be newly constructed using a nonseparated mixed-use approach. The building is three (3) stories in height, containing primarily Group A and E occupancies, with Group A Assembly spaces primarily consisting of the Gymnasium, Auditorium, and Cafeteria on the first floor. The building will be designed as Type IB fire resistive, non-combustible construction.

Under Type IB Construction, Group E occupancies are permitted to be six (6) stories in height with unlimited area per floor. Group A occupancies are permitted to be twelve (12) stories in height with unlimited area per floor. As the gymnasium, auditorium, and cafeteria will be used for public events, they are classified as Group A-3 spaces, while the balance of the school is classified as Group E educational use. The current design does not include occupancy separations as the building is permitted to be unlimited in area. As the building is 3-stories in height and permitted to have unlimited area, the current design is compliant.

In order to demonstrate compliance with the allowable building area requirements of MSBC Section 506, the sum of the ratios on each floor must be individually analyzed. This approach involves taking the area of each occupancy, and dividing this area by the allowable area of each occupancy on a floor-by-floor basis (MSBC Section 506.2.4). As the building is permitted to have unlimited area on each floor, the sum of the ratios calculation is not applicable.

As the building will be of Type IB construction, the stairs and shafts must be constructed of 2-hour construction as Type IB requires a 2-hour rated floor assembly.

### ***FIRE RESISTANCE RATING***

The fire-resistance rating requirements for Type IB construction can be found in MSBC Table 601. The fire-resistance ratings for the building structural elements are as follows:



**Fire Resistance Ratings of Structural Elements for Type IB Construction**

BUILDING STRUCTURAL ELEMENT	FIRE RESISTANCE RATING – TYPE IB
<b>Structural Frame</b> Including girders, beams and trusses (other than columns): Supporting a floor Supporting roof only Columns: Supporting a floor Supporting roof only	2-hour 1-hour 2-hour 1-hour
<b>Bearing Walls</b> Exterior Interior Walls: Supporting more than one floor Supporting only roof	2-hour 2-hour 2-hour
<b>Nonbearing Walls and Partitions</b> Exterior ( <i>not less than fire separation requirements</i> ) Interior ( <i>not less than fire separation requirements</i> )	See Fire Separation 0-hours
<b>Floor Construction</b> Including supporting beams and joists	2-hour
<b>Roof Construction</b> Including supporting beams and joists: Less than 20' in height to lowest member 20' or more in height to lowest member	1-hours 0-hours

**EXTERIOR WALLS**

The MSBC regulates the fire resistance rating of exterior walls and the extent to which protected and unprotected openings are permitted in the exterior walls of facing buildings based on the fire separation distance to the lot line or to the center of the street (MSBC Table 602 and Table 705.8).

It should be noted that the Farley building is located approximately 40-feet away from the proposed Fuller School. The Farley building is constructed of non-combustible brick exterior walls. As such, the Fuller School is not provided with 100% open frontage on all sides. **The existing Farley Building was confirmed by JLA to be of masonry construction, with no exterior openings on the portions closest to the proposed Fuller School.**

**In order to determine the allowable openings and rating of the exterior walls of the Fuller School, an assumed lot line must be developed between the Farley building and the Fuller School. Based on the masonry exterior walls of the Farley Building, it is assumed that the Farley Building is provided with 1-hour rated exterior walls. With no openings in the exterior wall, the Fuller School will be permitted to have unlimited openings and a non-rated exterior wall. Specific detail of the Farley wall construction should be provided for a detailed review to ensure a 1-hour rated exterior wall exists.**

### Fire Resistance Rating for Exterior Non-Loading-Bearing Walls

Based on Fire Separation Distance (IBC Table 602)

<b>FIRE SEPARATION DISTANCE (Building wall to property line for each side of the building)</b>	<b>FIRE-RESISTANCE RATING (GROUP A, B, E, S-2)</b>
<i>Less than 5 feet</i>	1-hour
<i>Greater than or equal to 5 feet and less than 10 feet</i>	1-hour
<i>Greater than or equal to 10 feet and less than 30 feet</i>	1-hour
<i>Greater than or equal to 30 feet</i>	0-hour

The required fire-resistance rating of exterior walls with a fire separation distance of greater than 10 feet must be rated for exposure to fire from the inside. The required fire-resistance rating of exterior walls with a fire separation distance of less than or equal to 10 feet must be rated for exposure to fire from both sides.

### Maximum Area of Exterior Wall Openings

Based on IBC Table 705.8

<b>Fire Separation Distance to Lot Line (feet)</b>	<b>Allowable Area of Opening (Sprinklered)</b>
0 to less than 3	Not Permitted
3 to less than 5	15%
5 to less than 10	25%
10 to less than 15	45%
15 to less than 20	75%
20 to less than 25	No Limit
25 to less than 30	No Limit
30 or greater	No Limit

The Farley building is not provided with openings on the portions of the building that will face the proposed Fuller School. As mentioned above, the allowable openings of the Fuller School will be determined upon confirmation of the assumed lot line between the Fuller School and the Farley Building. The Fuller School will likely be permitted to have unlimited openings based on the 1-hour rated exterior walls and lack of openings in the Farley Building.

### Fire Resistant Joint Systems

Joints installed in or between fire-rated walls, floors or floor/ceiling assemblies and roofs or roof/ceiling assemblies must be protected by an approved fire-resistant joint assembly having a rating equal to the rating of the wall, floor, or roof. Joint systems shall be tested in accordance with MSBC Section 715.0.

Listed and approved joint assemblies must be provided for all concealed locations where fire resistance rated assemblies form a joint.

### Interior Finishes and Floor Finishes

Interior finishes in the building are required to meet the requirements of MSBC Section 803 for Interior Finish. Refer to the following tables for details. Interior finish applies to wall and ceiling finishes. Interior floor finish applies to floor coverings.

**Interior Wall & Ceiling Finish Requirements by Occupancy**

Sprinklered Building (Table 803.11)

USE GROUP	VERTICAL EXITS AND PASSAGEWAYS	EXIT ACCESS CORRIDORS	ROOMS AND ENCLOSED SPACES
A-3	A or B	A or B	A, B, or C
B / E	A or B	A, B, or C	A, B, or C
S	A, B, or C	A, B, or C	A, B, or C
Atrium	A or B	A or B	A or B

**Interior Floor Finish Requirements by Occupancy**

Interior floor finish and floor coverings must comply with IBC Section 804, unless the floor finish or covering material is of traditional type, such as wood, vinyl, linoleum, or terrazzo and resilient floor covering materials not comprised of fibers.

***LABORATORY HAZARDOUS CHEMICAL STORAGE***

**Control Area Approach**

The MSBC permits limited amounts of hazardous materials in a Use Group E Educational Occupancies. Under this approach, each floor of the building is permitted to have a certain number of Control Areas that are separated by fire resistance rated construction. The number of Control Areas and quantity of hazardous materials permitted on each floor varies based on the ease of fire department access to those given spaces.

The control areas should be separated from adjacent spaces by one (1)-hour fire resistance rated separations on the First through Third Floors (MSBC Table 414.2.2). The required fire resistance rating for the floors and their supporting construction is one (1) hour rated, which is satisfied by the 2-hour floors per Type IB Construction. Doors in the one (1)-hour control area separation should be rated for ¾-hour and doors (MSBC Table 716.5). It should be noted that unprotected vertical openings are not permitted in control areas, unless a sum of the ratios for chemical quantity is utilized.

Multiple control areas per floor can be provided if they are separated with fire resistance rated fire barrier. Table 414.2.2 of the MSBC (shown below) provides the requirements for control area design by floor level in the building. It should be noted that the number of control areas permitted, and the maximum allowable quantity of hazardous materials permitted per control area is reduced on floors above and below grade. Hazardous materials in storage and in use within this control area will be limited to the quantities specified in MSBC Table 307.1 (1) and (2). The quantity limits shown include an allowable increase for approved storage and automatic sprinkler protection.

**MSBC Table 414.2.2 Design and Number of Control Areas**

Floor Level		Percentage of the Maximum Allowable Quantity Per Control Area	Number of Control Areas Per Floor	Fire-Resistance Rating for Fire Barriers in Hours	Actual Control Areas Provided
Above	3	50	2	1	2
Grade	2	75	3	1	1
Plane	1	100	4	1	2

- a. Percentages shall be of the maximum allowable quantity per control area shown in Tables 307.1(1) and 307.1(2) with all increases allowed in the notes to those tables
- b. Fire barriers shall include walls and floors and supporting construction as necessary to provide separation from other portions of the building.

As can be seen from the table above, the First Floor is allowed to have four (4) control areas. Above grade floors are permitted to have fewer control areas and each control area above grade is permitted to store less hazardous materials.

Table 414.2.2 of the MSBC (shown above) provides the requirements for control area design by floor level in the building. The IBC has a defined threshold for when an occupancy must be classified as a Group H High Hazard occupancy. The maximum allowable quantity per control area for hazardous materials is found in IBC Section 307. **If the quantities from Table 307.1(1) are exceeded, the occupancy must be classified as a Group H occupancy.** Table 307.1(1) also indicates what Hazard Occupancy Group (Group H-1 through H-5) the building must be classified as when the quantities in Table 307.1(1) are exceeded.

**As previously detailed in the report, an atrium connects the three (3) floors of the building. There should be multiple control areas per floor, which would require that rated walls separate the science classrooms from the balance of the building which entails 1-hour rated separations per NFPA 45.**

**Fire Code Requirements for Hazardous Chemicals**

The Massachusetts Fire Code 527 CMR adopts and amends the 2015 version of NFPA 1. Chapter 66 from the Massachusetts fire code contains the requirements for Flammable and combustible liquids. The Massachusetts fire code requires that the storage, handling and use of flammable or combustible liquids comply with NFPA 30. According to Section 1.5.3, a laboratory installation made in accordance with NFPA 45 is determined to be in compliance with NFPA 30.

**66.1.1\*** *The storage, handling, and use of flammable and combustible liquids, including waste liquids, as herein defined and classified, shall comply with this chapter; NFPA 30, Flammable and Combustible Liquids Code; Sections 60.1 through 60.4 of this Code; and NFPA 35 Standards for the Manufacture of Organic Coatings, as applicable.*

## Most restrictive requirements NFPA 30 and NFPA 45-

It is noted that NFPA 30 does not govern storage of liquids in a laboratory. In the open work area of the laboratory, the quantity of flammable liquid in the work area is governed by NFPA 45, which is the standard on fire protection for laboratories using chemicals.

The Massachusetts Fire Code Section 66.1.4 from the states that a laboratory that is installed in accordance with NFPA 45 is considered in compliance with the NFPA 1. Furthermore, it is noted that in accordance with Section 1.5.3 of NFPA 30, a laboratory that is installed in accordance with NFPA 45 is considered in compliance with NFPA 30.

**As discussed above, Howe Engineers confirmed with the staff liaisons for NFPA 30 & NFPA 45 that a laboratory installed in compliance with NFPA 45 is considered to be in compliance with NFPA 30 per Section 1.5.3 of NFPA 30.**

### 1.5.3 Installations made in accordance with the applicable requirements of the following standards shall be deemed to be in compliance with this code:

- (1) NFPA 1, *Fire Code*
- (2) NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*
- (3) NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*
- (4) NFPA 31, *Standard for the Installation of Oil-Burning Equipment*
- (5) NFPA 32, *Standard for Drycleaning Plants*
- (6) NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
- (7) NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*
- (8) NFPA 35, *Standard for the Manufacture of Organic Coatings*
- (9) NFPA 36, *Standard for Solvent Extraction Plants*
- (10) NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*
- (11) NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*
- (12) NFPA 99, *Health Care Facilities Code*
- (13) NFPA 101, *Life Safety Code*

Figure 1: NFPA 30 Section 1.5.3 states installations made in accordance with NFPA 45 are considered in compliance with NFPA 30.

**66.1.4** Installations made in accordance with the applicable requirements of the following standards shall be deemed to be in compliance with this Code.

- (1) NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*
- (2) NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*
- (3) NFPA 31, *Standard for the Installation of Oil-Burning Equipment*
- (4) NFPA 32, *Standard for Drycleaning Plants*
- (5) NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
- (6) NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*
- (7) NFPA 35, *Standard for the Manufacture of Organic Coatings*
- (8) NFPA 36, *Standard for Solvent Extraction Plants*
- (9) NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*
- (10) NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals***
- (11) NFPA 99, *Health Care Facilities Code*
- (12) NFPA 101, *Life Safety Code*

**Figure 2: NFPA 1 Section 66.1.4 states installations made in accordance with NFPA 45 are considered in compliance with NFPA 1.**

**NFPA 45 Laboratory Installation Requirements**

In NFPA 45, Laboratories are classified as Laboratory Units A through D. Classification A representing a high hazard and D minimum fire hazard. The difference being the quantity of flammable and combustible liquids permitted to be utilized in the laboratory. Table 5.1.1 from NFPA 45 contains the requirements for the separation, maximum area and number of stories above and below grade that a lab can be located. This table is similar to the requirements contained in Table 414 of the International Building Code. (It is noted for reference that Table 5.1.1 has been updated in the 2015 version of NFPA 45 to clarify that Class C and D laboratories are permitted to be located in a story below grade.) In accordance with Table 5.1.1, fire separation is not required for Class C or D laboratories for Educational Buildings and be limited to 50% of the values shown in the table on the next page.

**Table 5.1.1 Separation Requirements and Height Allowances for Laboratory Units**

Laboratory Unit <sup>a</sup>	Area of Lab Unit	Fire Separation <sup>b</sup>	Permitted Stories Above Grade
A	≤929 m <sup>2</sup> (≤10,000 ft <sup>2</sup> )	2 hours	1-3 <sup>c</sup>
	>929 m <sup>2</sup> (>10,000 ft <sup>2</sup> )	Not permitted <sup>d</sup>	
B	≤929 m <sup>2</sup> (≤10,000 ft <sup>2</sup> )	1 hour	1-3 <sup>c</sup>
	≤929 m <sup>2</sup> (≤10,000 ft <sup>2</sup> )	2 hours	4-6 <sup>c</sup>
	>929 m <sup>2</sup> (>10,000 ft <sup>2</sup> )	Not permitted <sup>d</sup>	
C	Any size	Not required	1-3
	Any size	1 hour	4-6
	Any size	2 hours	Over 6
D	Any size	Not required	No limit

<sup>a</sup>Refer to Table 10.1.1 for laboratory unit classification.  
<sup>b</sup>Separation in this table refers to separation from laboratory unit(s) to non-laboratory areas and/or separations from laboratory unit(s) of equal or lower hazard classification.  
<sup>c</sup>Not allowed in structures below grade.  
<sup>d</sup>Labs of this classification and size are not permitted.

### NFPA 45 Requirements for Maximum Allowable Quantities of Flammable Liquids.

Chapter 10 from NFPA 45 contains the quantity limitations for flammable and combustible liquids. The maximum allowable quantities for flammable and combustible liquids can be found in Table 10.1.1(b) (See Table 10.1.1(b) below).

**Table 10.1.1(b) Maximum Quantities of Flammable and Combustible Liquids in Laboratory Units Outside of Inside Liquid Storage Areas (U.S. Customary Units)**

Laboratory Unit Fire Hazard Class	Flammable and Combustible Liquid Class <sup>a</sup>	Quantities in Use <sup>a</sup>		Quantities in Use and Storage <sup>a</sup>	
		Maximum Quantity <sup>b</sup> per 100 ft <sup>2</sup> of Laboratory Unit <sup>c</sup>	Maximum Quantity <sup>b</sup> per Laboratory Unit	Maximum Quantity <sup>b</sup> per 100 ft <sup>2</sup> of Laboratory Unit <sup>c</sup>	Maximum Quantity <sup>b</sup> per Laboratory Unit
		gal	gal	gal	gal
A (high fire hazard)	I, II, and IIIA	10	480	20	480
		20	800	40	1600
B <sup>d</sup> (moderate fire hazard)	I, II, and IIIA	5	300	10	480
		10	400	20	800
C <sup>e</sup> (low fire hazard)	I, II, and IIIA	2	150	4	300
		4	200	8	400
D <sup>e</sup> (minimal fire hazard)	I, II, and IIIA	1	75	2	150
		1	75	2	150

Note: For maximum container sizes, see Table 10.1.2.

<sup>a</sup>The maximum amount in use in open systems is limited to 10 percent of the quantities listed.

<sup>b</sup>See 4.2.2 for additional requirements for educational and instructional laboratories.

<sup>c</sup>The quantities per 100 ft<sup>2</sup> do not imply the quantities must be within that 100 ft<sup>2</sup> area; the quantities per 100 ft<sup>2</sup> are for calculation purposes to determine the total quantity allowed per laboratory work area and the total amount overall in the laboratory unit.

<sup>d</sup>Reduce quantities by 50 percent for B laboratory units located above the 3rd floor.

<sup>e</sup>Reduce quantities by 25 percent for C and D laboratory units located on the 4th–6th floors of a building and reduce quantities by 50 percent for C and D laboratory units located above the 6th floor.

- The maximum allowable quantity permitted by Table 10.1.1 is based on a per 100 sq. ft. of laboratory area.

### **NFPA 45 Instructional Laboratory classification**

It is noted that NFPA 45 has a designation for Instructional Laboratories, which is classified as a lab that is used for educational purposes for college aged students. Experiments and testing in an Instructional Lab is typically conducted under supervision of a lab instructor.

**3.3.31 Instructional Laboratory Unit.** A laboratory unit used for education past the 12th grade and before post-college graduate-level instruction for the purposes of instruction of six or more persons for four or more hours per day or more than 12 hours per week. Experiments and tests conducted in instructional laboratory units are under the direct supervision of an instructor. Laboratory units used for graduate or post-graduate research are not to be considered instructional laboratory units.

### **Summary of the Maximum Allowable Quantities from IBC, NFPA 30 and NFPA 45**

Howe Engineers has provided the following table to summarize the various requirements for maximum allowable quantities from the International Building Code, NFPA 30 and NFPA 45. It is noted that NFPA 45 is most restrictive in the maximum allowable quantities for storage and use of flammable and combustible liquids. It is noted that the maximum allowable quantities in Table 1 assumed that the NFPA 45 maximum allowable quantities are not reduced due to the floor area of the laboratory. **The maximum allowable quantity permitted by NFPA 45 Table 10.1.1 is based on a per 100 sq. ft. of laboratory area and a reduction of 50% of the maximum allowable quantity listed in the table below per the Educational requirements**

Please refer to Table 1 below for the for maximum allowable quantities from the International Building Code, NFPA 30 and NFPA 45:



***PENETRATIONS OF DUCT AND AIR TRANSFER OPENINGS***

**MEP Shaft Enclosures**

A shaft is required when the duct penetrates two (2) or more floor/ceiling assemblies (MSBC Section 717.6.1). A shaft is not required in occupancies other than Groups I-2 and I-3, for a duct constructed of approved materials in accordance with the International Mechanical Code that penetrates not more than one (1) fire-resistance-rated floor/ceiling assembly (connecting only 2 stories), provided a listed fire damper is installed at the floor line or the duct is protected in accordance with MSBC Section 714.4 (MSBC Section 717.6).

MSBC Section 713.4 provides that shafts connecting less than four (4) stories, a 1-hour fire rated shaft enclosure is required. Shafts connecting four (4) or more stories require a fire-resistance rating of at least two (2) hours. Additionally, shaft enclosures must not have a fire resistance rating that is less than the rating of the floor that they are penetrating, but need not exceed two (2) hours. Openings in a shaft enclosure are required to be limited to those necessary for the purpose of the shaft (MSBC Section 713.8.1). Where shafts do not extend to the top or bottom of a building, adequate protection should be provided (MSBC Section 713.11 and Section 713.12). **It should be noted that as the building is of Type IB construction, shafts must be provided with a 2-hour fire resistance rating as they penetrate 2-hour rated floor assemblies.**

**The building will have shafts at each bathroom suite to accommodate bathroom exhaust. Additionally, shafts will be located above the administrative suites to accommodate ductwork associated with these office areas. Finally, kiln exhaust and various fume hoods throughout the building will be provided with 2-hour rated shafts.**

**Fire Dampers**

Fire dampers should have a fire resistance rating in accordance with the table below (MSBC Table 717.3.2.1). The actuation temperature of the actuating device should be approximately 50°F above the normal temperature within the duct system (MSBC Section 717.3.3.1). If a fusible link is used, it should have a temperature rating not less than 160°F (MSBC Section 717.3.3.1).

**Fire Damper Rating**

Type of Penetration	Minimum Fire Damper Rating
Less than 3-hour fire-resistance rated assemblies	1½ hours
3 hour or greater fire-resistance rated assemblies	3 hours

Fire dampers are required at locations where ducts or air transfer openings of an air distribution system penetrate fire resistance rated assemblies including the following:

- Fire barriers (MSBC Section 717.5.2);
- Shaft enclosures (MSBC Section 717.5.3);
- Fire partitions (MSBC Section 717.5.4);

- Horizontal assemblies (MSBC Section 717.6).

**Smoke Dampers**

Actuation of smoke dampers should be achieved in accordance with the table below (MSBC Section 717.3.3.2).

**Smoke Damper Actuation Methods**

Damper Location	Activation Method
Within a duct	Activation controlled by a smoke detector within 5-feet of the damper with no air outlets or inlets between the detector and the damper.
Above smoke barrier doors in a smoke barrier	Activation controlled by a spot type detector listed for releasing service should be installed on both sides of the smoke barrier door opening.
In an un-ducted opening in a wall	Activation controlled by a spot type detector listed for releasing service should be installed within 5-feet of the damper.
In a corridor wall	Activation controlled by smoke detector system in the corridor.
All	Where a total-coverage smoke detector system is provided within areas served by HVAC system, dampers are permitted to be controlled by the smoke detection system.

Smoke dampers are required at locations where ducts or air transfer openings of an air distribution system penetrate assemblies; including:

- Shaft enclosures (MSBC Section 717.5.3);
- Smoke barrier walls (MSBC Section 717.5.5);
- Horizontal Exits in fire walls (MSBC Section 717.5.1);
- Corridors (MSBC Section 717.5.4.1);
- Smoke Partitions (MSBC Section 717.5.7).
- Smoke-tight construction (MSBC Section 509.4.2)

**It should be noted that smoke dampers are not required in smoke control systems where actuation of the damper would interfere with the operation of the smoke control system (717.5.3 Exception 3).**

**The table below reiterates smoke damper (SD) requirements and provides a number of exceptions in accordance with the MSBC.**

### **Combination Smoke/ Fire Dampers**

Where penetration of a smoke barrier is required to be provided with a fire damper, a combination fire and smoke damper equipped and arranged to be both smoke and heat responsive should be provided (MSBC 717.5). Combination smoke / fire dampers are required in the following location:

- Shaft penetrations (MSBC 717.5.3).

**The table below reiterates combination smoke / fire damper requirements and provides a number of exceptions in accordance with the MSBC.**

#### **Through Penetration Protection**

Penetrations into or through fire barriers, smoke barrier walls, fire partitions, floor/ceiling assemblies, or the ceiling membrane of a roof/ceiling assembly are required to be protected with an approved penetration or membrane penetration assembly (MSBC 708). See MSBC 708 for exceptions.

#### **Damper Exceptions**

The table below been developed by Howe Engineers in identifying where dampers are required and where exceptions exist.

	FD	SD	MSBC	Applicable SD, FD & SD/FD Damper Exceptions
Fire Barriers (including horizontal exits) <sup>1</sup>	Required	Not Required (NR)	717.5.2	Penetrations tested in accordance with ASTM E119 as part of a fire-resistance rated assembly (FD). [MSBC §717.5.2 Exception 1]
				Ducts used as part of an approved smoke control system (FD). [MSBC 717.5.2 Exception 2]
				Where fire barriers walls have a FRR of less than 1-hour and the following conditions apply: • The Building is protected throughout by automatic sprinklers; • Penetrations are limited to a ducted HVAC system conveying supply, return or exhaust air; • HVAC ducts are minimally 26 gage; • HVAC ducts are continuous from the AHU to the air outlet and inlet terminals (FD). [MSBC 717.5.2 Exception 3]
Smoke Barriers <sup>2</sup>	NR	Required	717.5.5	Smoke dampers are not required where openings in ducts are limited to a single smoke compartment and ducts are constructed of steel (SD). [MSBC 717.5.5 Exception 1]
Floor / Ceiling Assemblies	Required	NR	717.6.1	A duct is permitted to penetrate two floors or less with a fire damper at each floor provided it meets all the requirements in 717.6.1 Exception (FD). [MSBC 717.6.1 Exception]
Shafts	Fire / Smoke Dampers Required		717.5.3	Steel exhaust sub ducts extending at least 22-inches vertically in an exhaust shaft provided there is a continuous upward airflow to the outside (FD). [MSBC 717.5.3 Exception 1.1]
				Penetrations tested in accordance with ASTM E119 as part of a fire-resistance rated assembly (FD). [MSBC 717.5.3 Exception 1.2]
				Ducts used as part of an approved smoke control system (FD). [MSBC 717.5.3 Exception 1.3]
				Fire dampers and combination fire/smoke dampers are not required in kitchen and clothes dryer exhaust systems when installed in accordance with the International Mechanical Code (SD/FD). [MSBC 717.5.3 Exception 5]. A duct that penetrates a fire-resistance rated floor/ceiling assembly that connects not more than 2 stories is permitted without a shaft enclosure, provided that a listed fire damper is installed at the floor line. [MSBC 717.6.3].
				Kitchen, clothes dryer, bathroom and toilet room exhaust openings are installed with steel exhaust sub ducts, having a minimum wall thickness of 0.187-inch (No. 26 gage), the sub ducts extend at least 22 inches vertically, and an exhaust fan providing continuous airflow to the outside is installed at the top of the shaft terminal. The exhaust fan should be provided with an uninterruptible power system for the first 15 minutes of loss of primary power (SD). [MSBC 717.5.3 Exception 2 for Group B and R occupancies only]
Corridors	NR	Required	717.5.4	Ductwork has a minimum wall thickness of 0.019 inches and there are not openings that serve the corridor (SD). [MSBC 717.5.4.1 Exception 2]
Fire Partitions	Required	NR	717.5.4	Ductwork does not exceed 100 square inches, constructed of steel a minimum of 0.0217 inch in thickness, does not have openings that communicate with the corridor, installed above the ceiling, shall not terminate at a wall register in the fire resistance rated wall, 12-inch long by 0.060-inch-thick steel sleeve centered in each duct opening and secured by rectangle angles (SD). [MSBC 717.5.4 Exception 3]

**Protected Vertical Openings**

Vertical openings through floors will be protected by fire-rated assemblies in accordance with MSBC Section 707.3. Vertical openings include exit stairs, elevator shafts, and mechanical shafts. Shafts and exit enclosures, other than *exit access stairways* complying with MSBC Section 1019.3 Item 4, will be enclosed with listed and approved shaft enclosure assemblies that provide a 2-hour fire-resistant rated noncombustible shaft assembly per MSBC Section 707.3, as the shafts will connect less than four (4) stories but penetrate 2-hour rated floor slabs (Type IB Construction). **Enclosed exit stairs within the building will be designed with 2-hour fire-rated separations.**

<sup>1</sup> Fire barriers within the building will include: Occupancy separations (if provided) and special use room enclosures.  
<sup>2</sup> Smoke barriers within the building will include: Fire service elevator lobby separations.

The floor openings requiring shaft protection will include, but are not limited to:

- Grease Ducts, Trash chutes and linen chutes
- Elevator Shafts
- Mechanical, electrical and plumbing shafts
- Exit Stairways, other than exit access stairways complying with MSBC Section 1019.3 Item 4.

Duct systems throughout the building that do not connect more than two (2) stories and are not required to be enclosed in shafts and are not required to be provided with smoke dampers, provided the annular space around the shaft is sealed with an approved material (MSBC, Section 714).

### ***ATRIUM DESIGN***

The current Fuller School design includes a three (3) story opening in the center of the building, with numerous breakout spaces within the opening. As the opening connects more than two (2) stories, the space is considered an atrium and must be designed in accordance with MSBC Section 404. Atriums are only permitted to be installed in buildings provided with approved automatic sprinkler protection (MSBC 404.3). Initially, it should be assumed that the building will require approximately 200,000 cfm of exhaust and associated make up air at the First Floor.

Section 404.5 requires a smoke control system to be installed in accordance with MSBC Section 909. The smoke control system can either be designed using natural or mechanical-ventilation but will require an engineering rational analysis to ensure adequate system performance. Equipment for the smoke control system must be provided with standby power. **The atrium will be provided with a smoke control system utilizing mechanical exhaust. Refer to the smoke control rationale analysis report drafted by Howe Engineers for further clarification on the system design. A basis of design addressing the preliminary FDS model results is presented in Appendix A of this document.**

Section 404.6 requires atrium spaces to be separated from adjacent spaces by a 1-hour fire barrier constructed in accordance with Section 707. A fire barrier is not required to enclose an atrium space when one (1) of the following arrangements are met:

- A glass wall forming a smoke partition is provided and sprinklers are provided along both sides of the separation walls and doors. Sprinklers must be located between 4 and 12-inches away from the glass at intervals along the glass not more than 6-feet. The sprinkler system must be designed to wet all surface of the glass upon activation. The glass wall must be installed in a gasketed frame in such a manner that the framing deflects without breaking the glass before the sprinkler operates. Where glass doors are provided, they must be self or automatic-closing.
- A glass block wall assembly complying with section 2110 having a ¾-hour rating is provided.
- A fire barrier is not required when the design is accounted for in the design of the smoke control system.

Atrium interior finishes must be class B or higher, with no reduction for sprinkler protection (Section 404.8).

It should be noted that unique egress requirements exist for atrium spaces in Section 404.9. Exit access travel distance through the atrium, not at the level of exit discharge, must not exceed 200-feet within the bounds of the atrium. Refer to the means of egress section of this report for further information.

### ***STAGE DESIGN***

The current Fuller School design includes a stage in the auditorium space on the First Floor. The requirements for stages are provided in MSBC Section 410. Section 410.3.1 requires stages to be constructed of materials as required for floors of the type of construction in which the stage is located. **As the building will be of Type IB Construction, the stage must be constructed of materials as required for floors.** In all types of construction, the finished floor must be constructed of wood or non-combustible materials. Openings through the stage floor must be equipped with tight-fitting, solid wood trap floors with approved safety locks.

Where the stage height is greater than 50-feet in height, all portions of the stage must be completely separated from the seating area by a proscenium wall with not less than a 2-hour fire-resistance rating extending continuously from the foundation to the roof (Section 410.3.4). Where a proscenium wall is required to have a fire-resistance rating, the stage openings must be provided with a fire curtain complying with NFPA 80, horizontal sliding doors complying with Section 716.5.2 having a fire protection rating of at least 1-hour, or an approved water curtain complying with section 903.3.1.1. **Based on the current set of drawings, the stage height is approximately 29-feet, thus a proscenium curtain is not required.**

Combustible scenery used in sets must meet the fire propagation performance criteria of Test Method 1 or 2, as appropriate of NFPA 701 in accordance with Section 806 of the International Fire Code.

It should be noted that the current stage design was measured to be approximately 1,580 square feet. Section 410.3.7 requires emergency ventilation for stages larger than 1000 square feet in floor area, or stages with a height greater than 50-feet. Ventilation must comply with Section 410.3.7.1 (roof vents) or 410.3.7.2 (Smoke control). **The stage will be provided with roof vents.**

Dressing and appurtenant rooms are required to be separated from the stage with rated construction in accordance with Section 410.5.1. Stages must be separated from dressing rooms, scene docks, workshops, storerooms and compartments appurtenant to the stage by fire barriers or horizontal assemblies. The fire-resistance rating must be 2-hour for stage heights greater than 50-feet, and not less than 1-hour for stage height of 50-feet or less. **As the stage is less than 50-feet in height, dressing rooms must be separated from the stage with 1-hour rated construction. Additionally, the AV rooms on the east and west sides of the stage will be provided with a 1-hour fire resistance rating.**

Stages must be provided with automatic sprinkler protection in accordance with Section 903.3.1.1. Sprinklers must be installed under the roof and gridiron and under all catwalks and galleries over the storage. Sprinklers must be installed in dressing rooms, performer lounges, and storerooms accessory to the stage (Section 410.7). Section 905.3.4 requires that stages greater than 1,000 square feet in area be provided with a Class III wet standpipe system with 1 ½-inch and 2 ½-inch hose connections on each side of the stage. **As the stage is greater than 1,000 square feet, it must be provided with a standpipe system as required by Section 905.3.4.**

It should also be noted that an accessible route must be provided to access the stage. **Refer to the accessibility section of this report for further clarification on the accessibility requirements associated with the auditorium space.**

**MEANS OF EGRESS SYSTEM DESIGN**

***GENERAL REQUIREMENTS***

**Occupant Load**

The occupant load for each space within the Building is determined using the occupant load factors listed in MSBC Table 1004.1.2, as shown in the table below.

<b>OCCUPANT USE GROUP</b>	<b>OCCUPANT LOAD FACTOR PER PERSON</b>
Classrooms	20 square feet (net) per person or actual occupant load
Lab Classrooms	50 square feet (net) per person
Unconcentrated Assembly Areas (Lounge, Collab, Cafeteria)	15 square feet (net) per person
Office/Business	100 square feet (gross) per person
Locker Rooms	50 square feet (gross) per person
Athletic Facility (Gymnasium)	50 square feet (gross) per person
Stage	15 square feet (net) per person)
Fixed Seating (Auditorium)	Actual Number of Seats
Circulation Space	100 square feet (gross) per person
Kitchen	200 square feet (gross) per person
Storage, Mechanical, Electrical	300 square feet (gross) per person
Bleacher Seating	18-inches per occupant

**Refer to the 60% CD Life Safety Drawings prepared by Howe Engineers for the occupant load of each floor of the proposed building.**

It should be noted that the design of the building entails classrooms with moveable partitions between individual rooms. As such, the calculated occupant load of individual classrooms does not represent the actual occupant load expected in each space. The life safety drawings depict an “actual” occupant load of 25-people per classroom, which includes students and staff members. **The approach of using a planned occupant load requires discussion and approval from the Authority Having Jurisdiction.**



### **Number of Exit Access Doorways**

Section 1006.2.1.1 requires that three (3) or more exits be provided when a space has a calculated occupant load of 501 to 1,000 and four (4) exits are required when the occupant load is greater than 1,000 occupants. Section 1006.2.1 requires two exits for all areas exceeding the occupant load in table 1006.2.1. For an A-3/E occupancy, two exits are required if the occupant load exceeds 49 occupants or where the common path of travel exceeds 75 feet. In Group B occupancy areas, two exits are required if the occupant load exceeds 49 occupants or where the common path of travel exceeds 100 feet. Further, in Group S-1/S-2 occupancy areas, two exits are required if the occupant load exceeds 29 occupants or where the common path of travel exceeds 100 feet.

**It should be noted that the first-floor occupant load exceeds 1,000, thus requiring four means of egress. The auditorium and gymnasium space are provided with their own dedicated egress doors leading directly to the exterior. The occupant load of the main school area is provided with four means of egress by means of doors to the exterior, and two (2) interior atrium stairways. It should be noted that the tech maker space, fab lab, art room, and media room on the first floor are all provided with a single 36-inch door that leads directly to the exterior of the building. Occupants in these rooms are expected to egress directly to the exterior of the building and do not need to enter the main building in order to egress. As such, the remainder of the first floor only requires three (3) means of egress, served by the two primary egress stairs, and the open stair within the atrium bounds.**

It should be noted that the means of egress for unique spaces such as boiler rooms, furnace rooms, and refrigeration machinery rooms is governed by Section 1006.2.2. Boiler rooms, incinerator rooms, and furnace rooms require two (2) means of egress where the area of the space is over 500 square feet and any fuel-fired equipment exceeds 400,000 BTU input capacity (Section 1006.2.2.1). Where two means of egress are required, one (1) is permitted to be a fixed ladder or an alternating tread device. The exits must be remotely located at a distance equal to one-half the length of the maximum overall diagonal dimension of the room. Refrigeration machinery rooms larger than 1,000 square feet must have at least two (2) exits (Section 1006.2.2.2). All portions of the machinery rooms must be within 150-feet of an exit or exit access doorway. Doors must swing in the direction of egress travel regardless of the occupant load served.

The current egress strategy involves occupants on the first-floor egressing upwards one story to exit through the main entry doors on Floor 2. MSBC Section 1006.3 permits the path of egress travel to pass through one (1) adjacent story to reach an exit. Occupants from Floor 1 would only pass through one adjacent story to reach the main entrance to the building, thus the approach complies with Section 1006.3.

**Arrangement of Means of Egress (MSBC Section 1007.1.1)**

Where two (2) exits, or exit access doors are required from a space, they must be placed not less than one-third the overall diagonal distance of the space, measured in a straight line between the exit doors or exit access doors.

Where there are three (3) or more exits, or exit access doors, at least two (2) of the exits or exit access doors are required to meet the remoteness as defined above. The additional exits shall be located as remotely as possible.

**The current arrangement of means of egress meets these criteria. The primary egress stairs are on opposite sides of the building, satisfying the one-third remoteness criteria.**

**Exit Capacities**

The exits within the building will be designed using the exit capacity factors listed in MSBC Sections 1005.3.1 and 1005.3.2. The exit capacity for stairs is calculated at 0.2 inches per occupant, while all other means of egress are calculated at 0.15 inches per occupant as the building will be fully sprinklered and provided with emergency voice/communication capabilities (Section 1005.3). The minimum required clear width shall not be less than those outlined within other sections of this report, which have been excerpted in the table below for reference.

LOCATION	EXIT CAPACITY NON-SPRINKLERED	MINIMUM REQUIRED CLEAR WIDTH
Stairways	0.20 inches per person	44 inches (MSBC Section 1011.2)
Doors	0.15 inches per person	32 inches (MSBC Section 1010.1.1)

**Refer to the 60% DD Life Safety Drawings prepared by Howe Engineers for the egress capacity and exiting strategy of each floor level. As seen in the life safety drawings, the means of egress capacity exceeds the occupant load on all floors. The use of the unenclosed egress stairs as a means of egress requires further discussion with Howe Engineers.**

**Exit Access Travel Distance (MSBC Section 1017)**

The Travel distance for each of the occupancies will be in accordance with the requirements contained in MSBC Section 1017.2 and Table 1017.2. Refer to the Table below:

OCCUPANCY	MAXIMUM ALLOWABLE TRAVEL DISTANCE (Sprinklered)
Group A, E, S-1	250 feet
Group B	300 feet
Group S-2	400 feet
Atrium	200 feet within atrium

Exit access travel distance must be measured from the most remote point within a story along the natural and unobstructed path of horizontal and vertical egress travel to the entrance of an *exit* (MSBC Section 1017.3). Where an exit access stairway or ramp is used as part of the means of egress system, the travel distance along the exit access stairway or ramp must be included in the exit access travel distance measurement (MSBC Section 1017.3.1). The measurement along exit access stairways and ramps must comply with the following:

- Stairways: measurements must be made on a plane parallel and tangent to the stair tread and nosings in the center of the stair and landings.
- Ramps: measurement along ramps must be made on the walking surface in the center of the ramp and landing.

Note that an “exit” is defined by MSBC Section 202 as that portion of a means of egress system between the exit access and the exit discharge or public way. Exit components include exterior exit doors at the level of exit discharge, *interior exit stairways and ramps, exit passageways, exterior exit stairways and ramps and horizontal exits.*

As addressed in the atrium design section of this report, the travel distance within the atrium is governed by Section 404.9. Where the path of egress travel is not on a level of exit discharge (i.e. Floor 3), the portion of the total permitted exit access travel distance that occurs within the atrium must not exceed 200-feet (Section 400.9.3).

**Egress through Intervening Spaces (MSBC Section 1016.2)**

Exit access from a room or space should not pass through an adjacent room or space, except where the room or area is accessory to the area being served. Exit access is not permitted to pass through kitchens, storerooms, restrooms, closets or other similar spaces. In addition, the exit access is not permitted to pass through rooms subject to locking.

**Common Path of Travel Limits (MSBC Table 1006.2.1)**

Maximum common path of egress travel distance is limited based on individual occupancies as outlined below.

- Business and Storage Occupancies 100 feet
- Assembly / Educational occupancies 75 feet

**Common path of travel is less than 75-feet in the Fuller School and thus is compliant.**

### **Dead End Corridor Limits (MSBC Section 1020.4)**

Per MSBC Section 1020.4, where more than one exit or exit access doorway is required, the exit access must be arranged such that there is no dead ends more than:

- Assembly Occupancies 20 feet
- Business Occupancies 50 feet
- Storage Occupancies 50 feet
- Educational Occupancies 50 feet

Note that a dead-end corridor is not limited where the length is less than 2.5 times the minimum width of the dead end. **Dead ends in the building will not exceed 20-feet.**

### **Exit Access Corridors (MSBC Section 1020)**

Corridors used for the exit access portion of the means of egress will be constructed in accordance with the MSBC Section 1020. The exit access corridors will provide sufficient clear width to accommodate the number of occupants exiting through the corridor, but will never be less than 44 inches unless serving an occupant load of less than 50 people, in which case they can be 36 inches.

**Per MSBC Table 1020.1, as the building will be fully sprinklered, rated corridors are not required.**

**It should also be noted that corridors in Group E occupancies with greater than 100 occupants are required to be 72-inches in width (Section 1020.2).**

### **Exit Stair Discharge**

The MSBC requires 50-percent of the enclosed interior exit stairways discharge to the exterior of the building and through the atrium. The remainder of the enclosed interior exit stairways are permitted to discharge to interior lobbies and vestibules (MSBC Section 1028.1). **The primary egress stairs on the east and west sides of the building both discharge directly to the exterior on the first floor and thus are compliant.**

### **Doors (MSBC Section 1010)**

Doors throughout the building must comply with MSBC Section 1010.1.

1. Dimensional Requirements (MSBC 1010.1.1)
  - Minimum clear width: 32 inches
  - Maximum size of a door leaf: 48 inches
  - Minimum Clear Height: 6 feet – 8 inches
2. Doors shall be side-hinged swinging in all spaces except within storage areas.
3. Doors serving a space with 50 people or more are required to swing in the direction of egress travel towards the exit.
4. While opening, doors are not permitted to project more than 50 percent of the required clear width in an exit stair or exit access stairway at any moment during the swing when opening. In addition, doors, when fully open, are not permitted to project more than 7 inches into the required exit clear width

### **Exit signage (MSBC Section 1013)**

1. Exit signs must be provided in each room or space that requires more than one (1) exit or exit access.
2. Exit signs must be placed such that no point within an exit access corridor is more than 100 feet or the listed viewing distance of the sign, whichever is less, from the nearest visible sign.
3. Main exterior exit doors or gates which obviously and clearly are identifiable as exits are not required to be provided with an exit sign where approved by the building official.
4. Every exit sign and directional exit sign must have plainly legible letters not less than 6 inches high with the principal strokes of the letters not less than  $\frac{3}{4}$  inch wide. The word "EXIT" must be in high contrast with the background and shall be clearly discernible when the exit sign illumination means is or is not energized. When an arrow is provided as part of the exit sign, the construction shall be such that the arrow direction cannot be readily changed.
5. Exit signs and exit directional signs can be externally or internally illuminated. The level of illumination at the sign's surface must be no less than 5-foot candles.
6. Exit signs shall be illuminated at all times and connected to an emergency power source having a duration of not less than 90 minutes. Emergency power shall conform to the National Electrical Code (NFPA 70).
7. Exit signs must be provided within 18-inches of the floor in electric rooms if the electric room has over 1,200 amperes and is more than 6-feet wide. In addition, panic hardware should be provided from these spaces.
8. **The International Symbol of Accessibility must be included on exit signs at exits to grade.**
9. Directional signage indicating the location of other means of egress and in which are accessible means of egress must be provided at the following locations:
  - a. At exits serving a required accessible space, but not providing an approved accessible means of egress.
  - b. At Elevator Landings
  - c. Within areas of refuge

### **Means of Egress Lighting (MSBC Section 1008)**

**Work areas will meet the following criteria as MSBC Section 1008 requires the following for means of egress lighting:**

- The means of egress, including the exit discharge, must be illuminated at all times the building space served by the means of egress is occupied, except aisle access ways in Group A occupancies.
- The means of egress illumination level must not be less than 1 foot-candle (11 lux) at the walking surface.
- The power supply for means of egress illumination must normally be provided by the premises' electrical supply. In the event of power supply failure, an emergency electrical system shall automatically illuminate all of the following areas:
  - Aisles and unenclosed egress stairways in rooms and spaces that require two or more means of egress.
  - Corridors, exit enclosures and exit passageways in buildings required to have two or more exits.
  - Exterior egress components at other than their levels of exit discharge until exit discharge is accomplished for buildings required to have two or more exits.

- All components to the access to public way must be illuminated
  - Interior exit discharge elements, as permitted in Section 1027.1 of the MSBC, in buildings required to have two or more exits.
  - Exterior landings as required by Section 1008.1.6 for exit discharge doorways in buildings required to have two or more exits.
- The emergency power system must provide power for a duration of not less than 90 minutes and must consist of storage batteries, unit equipment or an on-site generator. The installation of the emergency power system must be in accordance with Chapter 27 of the MSBC.
- Emergency lighting facilities must be arranged to provide initial illumination that is at least an average of 1 foot-candle (11 lux) and a minimum at any point of 0.1 foot-candle (1 lux) measured along the path of egress at floor level. Illumination levels are permitted to decline to 0.6 foot-candle (6 lux) average and a minimum at any point of 0.06 foot-candle (0.6 lux) at the end of the emergency lighting time duration. A maximum-to-minimum illumination uniformity ratio of 40 to 1 must not be exceeded.

## **FIRE PROTECTION SYSTEMS**

### ***SUMMARY OF FIRE PROTECTION FEATURES***

*The following Fire Protection and Life Safety Features are being provided in the building:*

1. The building will be constructed of a Type IB fire resistive non-combustible construction.
2. The building will be fully sprinklered and provided with standpipes as outlined in this section.
3. A manual fire alarm system will be provided in the building and will meet current NFPA 72 spacing requirements
4. Emergency voice/alarm communication systems will be installed in accordance with Section 907.2.3
5. Emergency Power and Standby Power for all life safety systems
  - a. At least one elevator will be available to operate on Standby power
  - b. Egress Signage and Lighting will be provided with Emergency Power.
  - c. The atrium smoke control system will be provided with Standby Power.
6. Portable fire extinguishers are being provided in supervised locations in accordance with NFPA 10.
7. The system will be zoned relative to an atrium zone and non-atrium zone.

### ***AUTOMATIC SPRINKLER PROTECTION***

The Fuller School will be provided with an automatic sprinkler system as required for Group E occupancies with fire areas larger than 12,000 square feet and as required by the M. G. L. 148 26 G. The atrium and stage are also required to be provided with sprinkler protection. The design densities of the sprinkler system will be determined by the engineer of record.

### ***STANDPIPES***

Standpipes are required throughout the building when the highest floor is greater than 30 feet above the lowest level of fire department access (MSBC Section 905). **Based on the building elevation drawings provided by JLA, the building height from the lowest level of fire department vehicle access to the highest occupiable floor is 28-feet. It should be confirmed by JLA that the lowest level of fire department access is the first floor and that the landscape around the building is not sloped to provide fire department access at a lower point. It should be noted that Class I standpipes are permitted in buildings provided with automatic sprinkler protection in lieu of a Class III standpipe.**

It should also be noted that the stage will require a Class III wet standpipe system with a 1 ½-inch hose connection installed in accordance with NFPA 13 or NFPA 14 on each side of the stage (Section 905.3.4). This requirement is applicable as the stage is greater than 1,000 square feet in area.

## ***FIRE ALARM***

Section 907.2.3 requires a manual fire alarm system for group E occupancies having an occupant load that exceeds 50. The manual fire alarm system must initiate emergency voice/alarm communication features in the building. Where smoke detectors or automatic sprinkler systems are installed, the systems must be connected to the building fire alarm system. **It should be noted that manual fire alarm boxes are not required in Group E occupancies where the building is fully sprinklered, the emergency voice/alarm communication system will activate upon sprinkler waterflow, and where manual activation is provided from normally occupied spaces.**

### **Manual Fire Alarm Pull Stations**

Manual fire alarm devices will be located no more than five (5) feet from the entrance to each exit. Additional manual fire alarm boxes will be located so that travel distance to the nearest box is no more than 200 feet. A Manual pull station will also be provided in a constantly attended locations to provide the capability to manually activate the fire alarm system in an emergency situation.

## ***SMOKE CONTROL***

As indicated in the atrium design section of this report, the atrium will require a smoke control system designed in accordance with MSBC Section 909. The system may be designed as either a natural or mechanical ventilation system, and an engineering rational analysis should be provided to document the intended design of the system function. A smoke control panel must be provided in accordance with MSBC Section 909.16. As indicated throughout this report, the smoke control system must be provided with standby power.

**Refer to Appendix A for the atrium smoke control basis of design letter. A full smoke control rational analysis will be drafted by Howe Engineers and included in future submissions.**

## ***EMERGENCY POWER***

The following systems shall be provided with emergency power:

1. Emergency lighting along the means of egress in the building and along the exit discharge at a minimum level of 1-foot candle. Emergency lighting shall be provided in those rooms when the area is occupied. Subject to the approval of the Authorities Having Jurisdiction.
  - a. Complete Emergency Lighting shall be provided to the exit discharge of the building exits as determined by the Authorities Having Jurisdiction.
2. Fire Alarm System and all associated equipment including but not limited to the following:
  - a. Fire alarm control panels (including all fire alarm control equipment throughout the facility).
  - b. Fire alarm controls.
  - c. Fire alarm power supply booster panels.
  - d. Digital fire alarm communicators and interface equipment.
  - e. Dedicated telephone line from the Fire Alarm Control Panel dialer.



- f. Manual pull stations
3. Exit and Directional Exit Signs.
4. Elevators (transferable)
5. Power Operated Locks (if provided)
  - a. Manual override controls for any electric locking or hardware in the entire building.

It should be noted that the atrium smoke control system will be required to be provided with standby power.

### ***ELEVATOR PROVISIONS***

An elevator is proposed in the southwest portion of the building which will serve the first through the third floor and will provide roof access.

Phase I and Phase II recall equipment prescribed by the ASME 17.1 elevator code will be provided for the elevators. Accessible elevators shall be located with the required travel distance as per the Accessibility Standards.

**Two-way communication devices must be provided at elevator lobby areas above grade (i.e. second and third floors).**

**It should be noted that the elevator machine room may require a fire-resistance rating matching the rating of the elevator shaft. This rating must be provided if openings are provided from the elevator machine room into the elevator shaft as the machine room directly abuts the elevator shaft. The elevator machine room is currently designed with openings into the elevator shaft, thus the machine room will be provided with a 2-hour rating to match the rating of the elevator shaft.**

### ***PORTABLE FIRE EXTINGUISHERS***

The Massachusetts State Fire Code (MSFC) adopts and amends the 2015 edition of NFPA 1, which requires fire extinguishers in Groups A, B, and E occupancies. As such, fire extinguishers must be provided throughout all enclosed areas of the building. Portable fire extinguishers will be provided in locations where required by NFPA 10. Basic requirements are as follows.

In accordance with MSBC Section 906.1, extinguishers will be required in the following locations:

- Not more than 75 feet of travel distance to a fire extinguisher. Fire Extinguishers need not be located in each room if the travel distance can be achieved and the extinguisher has the correct hazard classification for each hazard within the 75-foot travel distance.
- Portable Class BC in elevator machine rooms and kitchens (kitchens may require class K depending on contents and use)
- Shall not exceed 40 lbs. capacity

### **Actual Mounting Locations (2013 Edition NFPA 10)**

- Bottom of extinguisher at least 4" above the floor
- Top of extinguisher not more than 5 ft. above the floor
- 1-6.6 Fire extinguishers shall not be obstructed or obscured from view
- 1-6.5 Cabinets shall not be locked (However, if extinguishers are in locations subject to malicious use, the cabinets can be locked, but there must be a means to open them in an emergency. Example: breaking the glass)
- 1-6.3 Fire extinguishers shall be conspicuously located where they will be readily accessible and immediately available in the event of a fire. Preferably they shall be located along normal paths of travel, including exits from areas.
- 1-6.11 Operating instruction shall be located on the front of the extinguisher and be clearly visible (manufacturer requirement)
- 1-6.12 Fire extinguishers mounted in cabinets or wall recesses shall be placed so that the fire extinguisher operating instructions face outward.
- The location of such fire extinguishers shall be marked conspicuously (see 1-6.6)

### ***FIRE DEPARTMENT ACCESS***

Per 527 CMR Section 18.2.3.2, a fire department access road must be maintained / provided in a manner that allows for at least one (1) exterior door to be within 50 feet of the access road that can be opened from the outside. In addition:

- All points of the building must be within 150 feet of the fire department access road which is increased to 250 feet when the building is protected throughout by an automatic sprinkler system.
- The fire department access road must have an unobstructed width of not less than 20 feet, and an unobstructed vertical clearance of 13 feet 6 inches.
- A minimum 25-foot turning radius must be provided / maintained.
- The access road must be designed and maintained to support the imposed loads of fire department apparatus and must be provided with an all-weather driving surface.
- Turning radius must be approved by the AHJ, with a minimum turning radius of 25 feet.
- Where necessary, dead ends are permitted provided they do not exceed 150 feet in cumulative length.
- The access road plan must include an analysis and evaluation of fire apparatus maneuvers throughout the access roads created by sweep path analysis and turn simulation software.

***EMERGENCY RESPONDER RADIO COVERAGE***

Per the MSBC Section 916.1, all buildings must have approved radio coverage for emergency responders within the building based upon the existing coverage levels of the public safety communication systems of the jurisdiction at the exterior of the building. This section does not require improvement of the existing public safety communication systems. The emergency responder radio coverage must be in accordance with Section 510 of the International Fire Code.

The building is considered to have acceptable emergency responder radio coverage when signal strength measurements in 95 percent of all areas on each floor of the building have a minimum signal strength of -95 dBm must be receivable within the building and a minimum signal strength of -100 dBm must be received by the agency's radio system when transmitted from within the building. **A bi-directional antenna should be provided for the project. Further discussion with Framingham is required to determine the number of antennas needed for Fire, Police and EMS.**

## **ACCESSIBILITY**

As a new construction building, the Fuller School will be designed to be fully accessible and comply with MAAB as well as the 2010 Americans with Disabilities Act.

### ***GENERAL REQUIREMENTS***

The Fuller School must be designed to meet MAAB as well as the 2010 Americans with Disabilities Act. Both ADAAG and MAAB require that all entrances are accessible, changing rooms and showers are accessible, and that all bathrooms be designed to be accessible. Finally, it should be noted that MAAB requires all exterior pathways to be fully accessible and that if parking is provided that a certain percentage be accessible.

The following accessible features should be provided in the building.

- All bathrooms and locker rooms should be accessible. Locker rooms should include the following features:
  - 36-inch wide accessible routes around all lockers. (including between benches and lockers)
  - 5% but not less than one accessible locker
  - At least one accessible shower stall
  - Accessible toilet and plumbing fixtures
- The elevator will be fully accessible and meet gurney requirements
- All entrances must be accessible
- All exterior walkways must be accessible
- Classrooms must be accessible including all laboratory/ science classrooms. 5% but not less than one (1) of each type of equipment/ learning station should be accessible

### ***Public and Common Use Spaces***

The public and common use spaces are those spaces inside or outside the buildings that are used by residents and/or visitors. This includes the parking and assembly spaces on the ground floor. These spaces must be accessible per the requirements of 521 CMR and the 2010 ADAAG. These spaces should be on an accessible route at least 36- inches wide which connects accessible parking, accessible entrances, and public and common use spaces. Wherever possible, the accessible route should be the shortest possible route (521 CMR 10.2). All doorways and openings located in common use and public use spaces and along accessible routes should comply with 521 CMR Sections 26.2 through 26.11 and ADAAG Section 404.

**Accessible Means of Egress**

All spaces or elements that are required to be accessible must be provided with at least one accessible means of egress. In spaces required to be provided with multiple means of egress, each space must be served by at least two accessible means of egress. Exit access stairways are permitted to be considered part of the accessible means of egress when they are provided with a clear width of at least 48 inches between the handrails and two-way communication is provided at the elevator landings in accordance with 780 CMR Section 1009.3. The building is fully sprinklered and areas of refuge are not required to be provided at the exit access stairways. Two-way communication is required to be provided at the elevator landings, so that the exit access stairways in the school can be considered as part of the accessible means of egress.

**Parking**

Parking will be provided in accordance with the following MAAB table based on the number of spaces provided for the residential occupants and the potential assembly occupants. **One in eight accessible spaces, but not less than one, must be van accessible.**

23.2.1	<u>Total Parking in Lot</u>	<u>Required Minimum Number of Accessible Spaces</u>
	15-25	1
	26-50	2
	51-75	3
	76- 100	4
	101-150	5
	151-200	6
	201-300	7
	301-400	8
	401-500	9
	501-1,000	2% of total
	1,001 and over	20 plus 1 for each 100 over 1000

**Accessible Seating Requirements**

In places of assembly with fixed seating, the minimum number of accessible spaces provided must be in accordance with the table below:

<u>Total Seating</u>	<u>Wheelchair Spaces</u>
4 to 25	1
26 to 50	2
51 to 300	4
301 to 500	6
over 500	6, one additional space for each total seating capacity increase of 100.

When more than 150 seats are provided, the wheelchair seating locations must be provided in more than one (1) location and must be dispersed through the seating area. Accessible seating must be integral with the rest of the seating (i.e. shoulder to shoulder). Bleachers should be ordered with cutouts where accessible seating will be provided.

It should also be noted that ADAAG requirements will be applicable to the project. ADAAG Table 221.2.1.1 also requires six (6) wheelchair spaces to be provided in the auditorium as the space will have 421 fixed seats.

In addition to wheelchair seating locations, 1% of all fixed seats must be a companion seat consisting of an aisle seat with no armrests on the aisle side (or with removable or folding armrests on the aisle side).

Accessible seating positions are permitted to be clustered for bleachers, balconies and other areas having sight lights with a slope greater than 5%. Equivalent accessible viewing positions may be located on levels having accessible egress.

Ticket box offices and concession stands must be located on an accessible route, and a portion of the counter must be a maximum of 36 inches high for a length of at least 36 inches. A counter or auxiliary counter can be used to achieve this requirement.

**It should be noted that accessible seating must be provided in both the auditorium and the gym, which is provided with telescoping bleacher seating. The auditorium is provided with 421 fixed seats, thus must be provided with six (6) wheelchair seats (with a companion seat directly adjacent to the wheelchair space). The gymnasium must be provided with cutout sections in the telescoping seating to accommodate wheelchair spaces.**

**Additionally, within the auditorium spaces, assistive listening devices must be provided.** Assembly areas that accommodate at least 50 persons or with an audio-amplification systems must be provided with permanently installed assistive listening systems (521 CMR 14.5.1). If the assistive listening system serves individual fixed seats, such seats must be located within a 50-foot viewing distance of, and including the stage, and must have a complete view of the stage (521 CMR 14.5.3). Signage must be provided to notify patrons of the availability of a listening system and must comply with the signage provisions of 521 CMR 41.00.

**An accessible route must be provided to the performance area within the auditorium.**

**Where classrooms are provided with fixed seating, at least 5% but not less than one will be provided with an accessible route, accessible clear floor space, knee clearance, and table heights.**

**PLUMBING FIXTURES**

The Massachusetts Plumbing Code requires specific plumbing fixtures for various spaces in the building. The number of plumbing fixtures shall be determined based on the following factors, as excerpted from the Massachusetts State Plumbing Code, Section 10.10 Table 1.

The following table outlines the plumbing fixture requirements for new construction. The factors that dictate the fixture counts for the building depend on the intended and future function of the Fuller School. It should be noted that separate toilet facilities are required for staff and students.

Occupancy	Water closets			Lavatories		Drinking Fountains	Other Fixtures
	Male	Female	Urinals	Male	Female		
Education (Secondary)	1 per 90	1 per 30	1 per 90	1 per 90	1 per 90	1 per 75	1 service sink per floor
Education (Staff)	1 per 25	1 per 20	33% substitution	1 per 40	1 per 40	-	1 service sink per floor
Auditorium	1 per 600 seats	1 per 200 seats	1 per 200 seats	-	-	-	-

The following tables outline the required plumbing fixtures for the Fuller School based on the use of a programmatic occupant load. A program occupant load captures the intended use of spaces, as opposed to the calculated occupant load which tends to be more conservative in nature. **The use of a program occupant load requires discussion and approval from the plumbing official.**

Gender neutral toilets have been discussed for the building. The following provisions are applicable for the installation of gender neutral toilets in the Fuller School:

1. Gender neutral facilities are permitted for employees
2. Gender neutral toilets can only be counted one time towards plumbing fixture counts. Thus, they may be counted as either Male or Female.
3. When two (2) or more toilet facilities are required, Gender Neutral Toilets may replace these fixtures but only in pairs (E.g. one replaces a Male and the other replace a female fixture).
4. Once the minimum number of fixtures is provided Gender Neutral Toilets can be singularly provided.

**It should also be noted that 248 CMR Section 10.10(18)(h).6 requires all secondary schools that conduct physical activities on the school premises to be provided with separate men’s and women’s shower facilities to accommodate students. Based on preliminary discussion with the plumbing official, showers will be required at Framingham Fuller School. Showers should be provided for the largest population expected to use them at a given time (e.g. physical education class, or after school sporting event).**

**Fuller Plumbing Fixtures Calculation**

630 Students 120 Staff

**Educational Use - Use Group E (elementary)**

Required Fixtures per Code						Toilet Female Required	Toilet Male Required	Urinals Male Required	Lavatories each sex Required	Drinking Fountain Required
Students						1 per 30	1 per 90	1 per 90	1 per 90	1 per 75
Staff						1 per 20	1 per 25	33%	1 per 40	-

Floor Level	Occupants			Unisex Toilet		Toilet - Female		Toilet - Male		Urinals		Lavatories			Drinking Fountain		Classrm Sinks	Showers	Mop Sinks	Notes
	Total	Male	Female	Required	Provided	Required	Provided	Required	Provided	Required	Provided	Each sex Required	Female Provided	Male Provided	Required	Provided				
					See Below															
Floor 1 Students	210	105	105	0	1	4	12	2	5	2	7	2	11	11	3	3				
Floor 1 Staff	40	20	20	0	13	1	-	1	-	1	-	1	1	1	-	-			3	
Floor 2 Students	210	105	105	0	1	4	8	2	2	2	6	2	8	8	3	3				
Floor 2 Staff	50	25	25	0	3	2	-	1	-	1	-	1	1	1	-	-			2	
Floor 3 Students	210	105	105	0	1	4	8	2	2	2	6	2	8	8	3	3				
Floor 3 Staff	30	15	15	0	2	1	-	1	-	1	-	1	1	1	-	-			2	
	750	375	375	0	21	16	28	9	9	9	19	9	30	30	9	9	0	0	7	

Unisex Toilets provided:

Students 3 SPED

1 at Lockers

Staff 1 Central Office

1 Medical Suite

1 Kitchen

6 General

Total Toilet Fixtures Required 34

Total Toilet Fixtures Provided 77

**Community Service Areas - Use Group E - Non-Simultaneous Use**

420 Auditorium, 600 Gym

Required Fixtures per Code						Toilet Female Required	Toilet Male Required	Urinals Male Required
						1 per 200	1 per 600	1 per 200

**Assembly Use**

Floor Level	Occupants Total	Occupants Male	Occupants Female	Toilet Female Required	Toilet Female Provided	Toilet Male Required	Toilet Male Provided	Urinals Male Required	Urinals Male Provided	Notes
Floor 1	1,020	510	510	3	7	1	2	3	5	Plus 2 Unisex

Total Toilet Fixtures Required 7

Total Toilet Fixtures Provided 14 17 With Unisex



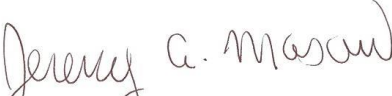
## **CONCLUSION**

The building is to be constructed in accordance with the requirements of the applicable Codes. During this process, the building will be designed to provide levels of safety at least equivalent to the provisions contained in the applicable codes. To achieve these levels of safety, the following primary features are provided:

1. The Building will be of Type IB fire resistive non-combustible construction and will comply with the separated mixed-use provisions of the MSBC.
2. The building will be fully sprinklered and provided with standpipes as outlined herein.
3. The means of egress system will be provided as outlined in this report and will meet the requirements of MSBC. Classrooms are proposed to use the actual number of students/ staff as opposed to the calculated occupant load.
4. The building will be provided with a manual fire alarm system and emergency voice/alarm communication abilities.
5. The atrium will be provided with a smoke control system that maintains tenability 6-feet above the highest walking surface. The smoke control system will be provided with standby power.
6. The building will be designed to be fully accessible in accordance with MAAB and ADAAG.
7. Plumbing fixtures will be provided in accordance with the provisions in the tables detailed above.

Prepared by,

Howe Engineers, Inc.

  
\_\_\_\_\_  
Jeremy A. Mason, P.E. (MA)  
Project Director

**APPENDIX A: SMOKE CONTROL BASIS OF DESIGN**

**APPENDIX C**

**FOOD SERVICE CUT SHEETS**



**CUT BOOK**

**of**

**FOODSERVICE EQUIPMENT**

**for**

**FULLER MIDDLE SCHOOL**

**FRAMINGHAM, MA**

**May 17<sup>th</sup> 2019**

**PLEASE NOTE:**

Cut sheets within this book are provided specifically for use by the owner or operator for their approval, and for use by the design engineers during the Construction Document development phase.

*They are not intended for use as bid documents.*

**F O O D F A C I L I T I E S P L A N N E R S**

161 West Main Street, Georgetown, Massachusetts 01833 phone: 978.352.8500 fax: 978.352.8588  
mail@crabtree-mcgrath.com



**PROJECT: Fuller Middle School**

**DATE: May 17<sup>th</sup>, 2019**

## **ARCHITECTURAL AND ENGINEERING INFORMATION FOR FOODSERVICE FACILITIES**

### **NOTE:**

1. The materials in this equipment cut book are specifically for the use of the owner or operator for their approval and for use by the design engineers during the Construction Document development phase. They are not intended to be used as bid documents.
2. The following material makes mention of various contractors in the related trades. These contractors are normally sub-contractors to the General Contractor, or directly engaged by the Owner depending on the project. It should be understood that the work of these contractors is not included under the Foodservice Equipment Contract (Section 114000).

### **ARCHITECTURAL**

Walls, floors and ceilings in foodservice areas must be smooth and readily cleanable. Materials that cannot withstand moisture and detergents must be avoided. Wall finishes that bear consideration are ceramic tile, glazed block, concrete block with flush joints, smooth finish and epoxy paint, and fiberglass panels. The minimum: epoxy paint over two layers of waterproof gypsum board on metal studs. The latter fails to meet the requirements of many inspectors when placed in a moist area such as potwashing, dishwashing or vegetable preparation. If there are exposed corners that can be damaged, we recommend that they be fitted with a rugged corner guard from the top of the coved floor to a point 48" above floor.

Walls located behind or beside cooking equipment must be of non-combustible construction. The 1998 edition of NFPA-96, chapter/paragraphs 1-3 and Appendix A greatly expand and illustrate the requirements of walls and grease duct enclosures.

Closure panels will be specified for major foodservice equipment items that join the building such as an exhaust ventilator or walk-in refrigerated rooms. Details will follow.

Ceilings criteria is on sound deadening and the ability to be cleaned. A number of materials are available from metal pans, lay-in mylar faced acoustic panels, to solid "plastered" ceilings. We recommend that ceilings be accessible. If possible, light fixtures should be installed flush with the ceiling.

Floors must be able to handle standing water, heat, falling items, and food chemicals. Further, they must be non-combustible and slip resistant. If the building's design age is for fifty years 'plus', be sure to

**F O O D F A C I L I T I E S P L A N N E R S**

161 West Main Street, Georgetown, Massachusetts 01833 phone: 978.352.8500  
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include a comparable floor. Many flooring materials are not capable of surviving the long run. The traditional fine quality foodservice flooring material is quarry tile that has been installed with a waterproof grout. Avoid very dark, very light and textured finishes as they always look dirty. All edges at walls should be covered up in order to maintain sanitary conditions. In order to make the flooring more slip resistant, the tile is available with textured finishes and embedded carbide grit in the surface. The textured finish is noisy when carts are rolled over it and the latter is very difficult to clean and it will shred a mop rapidly.

The alternative that we are seeing quite often is "Hubbellite" ([www.hubbellite.com](http://www.hubbellite.com)) or a member of the trowelled-on epoxy floors. This brand seems to have the most suitable characteristics. Many of the others are very slippery, or if made slip resistant they become impossible to clean. Check actual samples as we have found some are not slip resistant when wet. This material can be covered up at the walls.

It is reported that cost savings can be found with the sheet vinyl products. Flooring such as Altro's "High Performance Stronghold™ 30" offers the seamless surface, slip resistance and resiliency that many look for on kitchen floors. Before recommending it for a project, be sure to read the six page cleaning and maintenance brochure as this flooring material requires care. Reviewing its "Properties and Tests", it should be noted that it is suitable for temperatures from -4°F to +140°F. We have had two reports lately of a floor melting beneath a range and a floor igniting beneath a steam generator, both of which were mounted on 6" high legs. We must know about this material's selection in the design phase of the project to modify feet for the purpose of spreading weight. A 1,200 pound double deck convection oven rests on approximately 7 square inches of footprint exerting a force of 170 pounds per square inch that can squish the flooring from beneath the foot.

When walk-in refrigerated rooms are provided in a project, the preferred installation is one in which the rooms are flush with the adjoining building floor and of the same material. This finished flooring must be installed by the Flooring Contractor to the General Contractor. In order to install the rooms in this fashion, it is necessary to provide a 7" deep recess measured from the finished floor surface. Suggested details will follow.

NFPA 10, Standard For Portable Fire Extinguishers, Paragraph 2-3.2, requires Class K fire extinguishers for the protection of cooking appliances that use combustible cooking media (vegetable or animal oils and fats). This can affect the type and placement of hand held extinguishers normally specified by the Architect.

## **VENTILATION**

Exhaust blowers for exhaust ventilators and dishwasher connections shall be provided by the Heating and Ventilating Contractor. Blowers should be belt driven, adjustable and controlled by a switch with pilot light located within the area being exhausted. We will provide the required air volumes to be exhausted and the static pressure of the ventilator. Static pressure measurement shall be at the exhaust collar.

The HVAC Contractor shall make an approved type connection to this collar in accordance with NFPA 96, Vapor Removal From Cooking Equipment. Ductwork required for the connection of ventilators to the exhaust blower must be of at least 16 gauge carbon steel or 18 gauge stainless steel, all welded watertight construction, and pitched for proper drainage. Long horizontal runs should be avoided if at all possible. All ductwork shall be provided by the HVAC Contractor.

If ductwork between the blower and the ventilator is relatively short, take care to specify blowers with reduced noise output. Many times we visit the field to find the staff cooking without the blower running. When questioned, they claim excessive noise. Failure to operate the blower defeats the ventilator's grease and fume collection functions and many safety requirements when gas cooking equipment is in use.

Non-cooking exhaust ductwork such as dishwasher exhaust system, etc. cannot be connected to the grease ductwork. Separate systems must be maintained.

Warewashers will commonly be provided with stainless steel ductwork risers by the KEC to a point 3" above the finished ceiling. Riser size will be provided by our office. The KEC shall provide a balancing damper for each duct riser. HVAC Contractor shall make the connection to the two straight ducts above the ceiling. Ductwork must be self draining and rust resistant. The chemicals used with commercial warewashers will rot aluminum ductwork through time. If an exhaust canopy is to be provided, it will have a single exhaust connection point, and the size and air volume information will be provided by our office.

NFPA-96 chapter/paragraphs 4-8 state the requirements for ductwork termination and blower accessibility for duct cleaning.

A wet chemical fixed pipe fire suppression system shall be provided and installed by the KEC.

Conditioned make-up air must be supplied by a controlled means in proper quantity; a minimum of 75% of air exhausted through the hood or ventilator. Clean transfer air from adjacent spaces is an acceptable source of make-up air. The kitchen should operate at negative pressure to prevent kitchen odors from reaching adjacent areas. Exhaust and make-up air blowers should be interlocked to a control point located in the kitchen and a positive damper should be installed in the duct to prevent unwanted gravity caused air infiltration after the system has been shut down.

## **ELECTRICAL**

It has been brought to our attention that the National Electrical Code now requires Ground Fault Circuit Interruptor receptacles in all non-dwelling kitchen branch circuits. The engineering team will need to decide if a particular state has adopted NEC and when to provide such receptacles in a kitchen. It has been reported that commercial reach-in refrigerated cases are continually tripping GFCI outlets and causing serious problems with lost food or the task of moving the unit to reset the outlet. If possible, these outlets that are generally inaccessible should be provided with standard outlets. Convection ovens and combination ovens have been reported to trip GFCI outlets, therefore we recommend the use of Pass & Seymour 2095-W, 115 volt, 20 amp GFCI Duplex Receptacles. Our plans will no longer distinguish between normal receptacles and GFCI receptacles. Equipment specified by our office with mounted receptacles will be specified with GFCI's.

Food service equipment having motors, electrical heating units, lighting fixtures, receptacles and the like shall be internally wired to a junction box mounted on the equipment by the Kitchen Equipment Contractor. The components of remote refrigeration systems are not internally wired and require field wiring by the Electrical Contractor.

The Electrical Contractor shall furnish and install switches and receptacles not integral with the specified equipment and not called for in the "Item Specifications" of the project. The Electrical Contractor will furnish, install and connect all wiring and conduit from the junction box mounted on the items of equipment to the building electrical distribution system.

The Electrical Contractor shall mount and wire all motor starters and other electrical devices furnished under the Kitchen Equipment specifications that are not an integral part of the equipment furnished. The most common applications of remote electrical components would be the refrigeration systems for the refrigerated rooms or a garbage disposer. The latter has a remote control switch, remote solenoid valve, and sometimes, a remote starter or contactor.

Electrical Contractor shall provide disconnects if the code requires. Dishwashing and cooking areas of the kitchen are wet and steamy areas and care should be exercised in the selection of disconnects in these areas to comply with applicable codes. On many jobs that we visit, these are mounted on the dishwasher framework with an array of Unistrut and carbon steel running thread. This is unsightly, unsanitary, and undesirable. An attempt should be made to wall mount the disconnects to avoid the splashing of water.

All conduit and flexible conduits that are exposed to water, splashing, or weather should be liquid tight.

#### Fire suppression:

The fixed-pipe fire suppression system shall be provided and installed by the KEC. Sources of heat and fuel must be shut-off to all equipment located under the kitchen exhaust ventilator per NFPA 96 2011, paragraphs 10.4. This requirement includes electrical components subject to exposure in the event of a system discharge.

Shut-down of electrical equipment with the suppression system is accomplished by means of contactors or a shunt trip provided and installed by the Electrical Contractor for the required pieces.

The mechanical control head of the fire suppression system will be provided with appropriate "dry contacts" for the Electrical Contractor to utilize to activate (or deactivate) his components. All interwiring wiring is to be provided and installed by the Electrical Contractor.

#### Refrigerated rooms:

Wiring within the room must be kept to a minimum. Such wiring should be run in moistureproof conduit and should be sealed with brine putty or silicone to prevent moisture from entering and condensing in the light fixtures, boxes and conduit. Room manufacturers recommend use of a seal-off fitting, mounted exterior to the box to accomplish this task. It should be noted that the conduit needs to be sealed internally and externally. If not, warm moisture will be drawn into the conduit and make its way past the wiring.

Power feeds for the condensing units and evaporator coils are roughed in at their respective locations. The Electrical Contractor shall run six wires, 24 volts, between the two units to control defrost timing, etc. in separate conduit from power wires. The required heavy wiring between units of years ago has been eliminated. The thermostat, defrost timer and solenoid valve are now factory installed at the evaporator coil in each room.



The freezer drainline heat tape, provided by the KEC, shall be plugged into a full time live duplex outlet provided by the Electrical Contractor located in the vicinity of the evaporator coil.

All pieces of kitchen equipment that are shown on our plans with cords and plugs shall be provided with the proper cord and plug by the KEC.

Lighting for kitchen exhaust ventilators shall be furnished as part of the ventilator by the KEC and the wiring shall terminate in a single junction box. Electrical Contractor shall make the final connection and provide a remote switch. On the matter of general lighting for the kitchen and related serving areas, it is recommended that approximately 70 foot candles of illumination be provided. If fluorescent fixtures are used, we recommend deluxe warm white tubes so as to avoid distortion of the color or appearance of food. Fixtures must have lens covers, and cannot provide flat top surfaces that could accumulate dust.

Please advise our office early in the project if voltages other than 120/60/1, 208/60/1 and 208/60/3 are to be used. Many pieces of equipment are available in 440/460/480 volt characteristics. Due to difficulty in finding replacement parts for refrigeration units, we cannot recommend voltages above the 208 volt characteristic for that equipment.

## **PLUMBING**

There is a growing tendency to provide lower temperature hot water systems throughout a building. We are finding temperatures as low as 105°F. This is tolerable in the warewashing area because with a larger than normal booster it is possible to fill through the booster and maintain the required 180° F. rinse water. However, 130°F. water is still recommended at the potwashing sink if the detergents are to work. Consideration might be given to providing a second system with the 140° F. water to this equipment. Please advise our office if 140°F hot water is not available in the warewashing room.

Exposed mechanical connections to fixtures in the kitchen and related food service areas, including exposed piping, should be chrome plated in order to maintain sanitary and easily cleaned surfaces that are consistent with the rest of the kitchen and its equipment. The Kitchen Equipment Contractor shall furnish all water faucets and sink outlets with lever type wastes (usually 2" IPS size), and vacuum breakers for all equipment items that are designed to introduce water at less than 2" above flood level of the chamber or tank.

The KEC shall provide a pressure relief valve, pressure reducing valve, two temperature-pressure gauges and a shock absorber for installation on the connecting line between the hot water booster and the warewasher. The Plumbing Contractor must include a single drain valve for the booster with his piping, and make the required connections between the booster and the warewashing equipment. The temperature-pressure gauges should be mounted immediately after the pressure reducing valve on the inlet side of the booster, and on the outlet side to permit closely monitoring of the booster's correct operation.

Stubs for equipment should come out of walls wherever possible. All connecting piping should be neatly assembled by the Plumbing Contractor up away from the floor at least 12" and with a minimum of exposed horizontal runs that are difficult to clean. Care should be taken to specify that piping shall be run in a sanitary manner, off the floor, and supported on something other than steel running thread.

Interconnecting piping must not be reduced in size to a pipe smaller than the inlet size on the equipment or faucet.

Condensate drains in the walk-in refrigerated rooms shall be provided and installed under the Kitchen Equipment specifications.

All piping to the wet chemical fire suppression system shall be installed by the KEC. In a gas fired kitchen the Plumbing Contractor shall be responsible for the mounting of the gas shut-off valve (provided by the KEC) at an appropriate location on the gas line.

Gas fired ranges, ovens, steam generators, etc. will be furnished with gas pressure regulators to reduce pressure to 4" to 7" water column.

Traps for all sinks, troughs, drainers, etc. are to be furnished and installed by the Plumbing Contractor, and where exposed should be at least painted, if not plated, to be as attractive as possible.

Floor drains shall be utilized for any one or a combination of purposes such as area drain for general cleaning, to receive indirect waste lines from food preparation sinks, warewasher, hot food wells, cold pans, coffee drainers, ice machines, etc. For locations on our plans indicating floor sinks, we recommend the J.R. Smith Figure 3001, 12" square with 1/2" grate and dome strainer, or equal.

In cooking batteries, and occasionally at ice machines, we provide stainless steel floor pans with removable fiberglass grate sections. These require a coordinated installation between the Flooring, Plumbing and Kitchen Contractors. When complete, the pan's rim is to be flush with the adjacent finished floor.

Floor drains must be carefully located by the Plumbing Contractor during the roughing-in stage if they are to correctly serve their intended purposes in the kitchen. They must be correctly set for height so that the floors will pitch smoothly and evenly into them without creating a hazardous "hills and valleys" condition.

The Health Departments of most states indirect waste outlets from any sink or device in which a utensil or food item might be placed. These sinks or devices would be vegetable preparation sinks, cook's sink, utility sinks and warewashers. They join the multitude of previously indirectly wasted units such as ice bins, cold plates, steam tables, coffee urn drainers, and the like.

Up until recently, it has been contrary to the Massachusetts Plumbing Code. Massachusetts was unique in that the Plumbing Code required that all sinks be directly wasted or tight wasted. In a battle of code enforcement departments, the Plumbing Code usually won. We understand that the Massachusetts Plumbing Code has relaxed its stand and is leaving the decision to local inspectors, some of whom have allowed the more sanitary indirect waste connections. Our drawings will indicate indirect waste connections where appropriate. If you have an inspector who insists on the solid connections, please advise our office so that we can issue our plans accordingly.

The advent of FOG (Fats Oils and Grease) regulations on kitchen fixtures and sinks, floor troughs and floor drains, is being implemented with an assortment of local interpretations. We have seen the previous standard of running the pot sink through a grease interceptor, in turn run through an outside grease trap. Another project took all sinks and the dishwasher through this route. Another added the floor troughs at the kettle and braising pan. Another added the garbage disposers to the interceptors (we

have yet to figure out how you keep these devices flowing). We do not know where it is all going to end, so please keep a watchful eye and let us know what we should be noting on our drawings.

One further development is the requirement or the automatic grease removal system such as the Thermaco *Big Dipper*. Short of having a basement, connecting all the potential devices to it is impossible. If it is required, please advise our office so that we can provide an extended drainboard at the pot sink to permit parking of the on-floor device.

Cutsheet provided for design intent.  
Mop sink & faucet provided by PC

STAINLESS STEEL

# FABRICATED SERVICE & MOP SINKS



9-OP-40DF Shown



Notched Out Front Allows Ease of Emptying Mop Bucket



Fabricated Bowls are Welded Together at the Seams

9-OP-20 Shown



9-OP-40 Shown

Item #: \_\_\_\_\_ Qty #: \_\_\_\_\_

Model #: \_\_\_\_\_

Project #: \_\_\_\_\_

## FLOOR UNITS

### FEATURES:

Floor mounted unit eliminates the need of lifting heavy containers.  
Tile edge furnished on the rear.  
Bowls rectangular in design for increased capacity.

### CONSTRUCTION:

All TIG welded.  
Welded areas blended to match adjacent surfaces and to a satin finish.

### MATERIAL:

16 Gauge type "304" series stainless steel sink bowl.  
18 Gauge type "304" series stainless steel sink apron.

## STANDING UNITS

### FEATURES:

Leg mounted design.  
High back splash.

### CONSTRUCTION:

All TIG welded.  
Welded areas blended to match adjacent surfaces and to a satin finish.

### MATERIAL:

Heavy gauge type "304" series stainless steel.

Conventional



8-OP-16

Economy



4-OP-18

## 16" HIGH SIDE & BACK SPLASHES FOR 9-OP SERIES MOP SINKS

16 Gauge, 300 Series Stainless Steel  
Available with Back & Left Side, Back & Right Side or Back & Both Sides (Mounting Hardware Included)



MODEL	Fits Units:	Height Above Finished Floor (A.F.F.)
K-288LorR	9-OP-20	26"
	9-OP-40	32"
K-290LorR	9-OP-28	26"
	9-OP-48	32"
<b>Splashes Available on All 3 Sides</b>		
K-298	9-OP-20	26"
	9-OP-40	32"
K-299	9-OP-28	26"
	9-OP-48	32"

## SERVICE & MOP SINK ACCESSORIES



### MOP DRAINAGE TRAY

- 16 Gauge, 300 Series Stainless Steel
- Includes Cast 1/2" Drain & Plastic Hose
- Wall Mounted (Hardware not Included)
- 2" Tray Height with 6" Rear Splash (Overall Height)

MODEL L x W x H  
K-243 32" x 4" x 6"      Approx. Wt. 13 lbs.

FLOW RATE  
9.6 GPM/  
36.3 LPM

8" O.C.

K-240 SERVICE FAUCET

K-242 MOP HANGER - 23" Wide



K-16 FLOOR MOP SINK REPLACEMENT DRAIN



### UTILITY SHELF - 8" WIDE

inches	mm	MODEL	Approx Wt	Approx Cubes
24"	610	K-245	12 lbs.	1
36"	914	K-246	15 lbs.	2



K-244 HOSE & HANGER

Customer Service Available To Assist You 1-800-645-3166 8:30 am - 8:00 pm E.S.T.

Email Orders To: customer@advancetabco.com For Smart Fabrication™ Quotes Email To: smartfab@advancetabco.com or Fax To: 631-586-2023



Fuller Middle School  
Framingham, MA

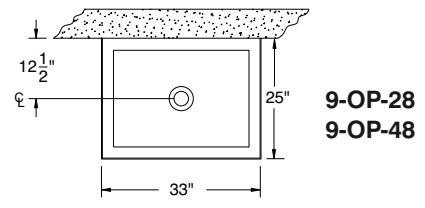
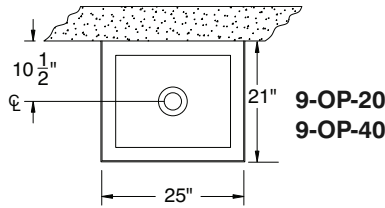
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Quantity: 1

# DIMENSIONS

TOL Overall:  $\pm .500''$   
 Interior:  $\pm .250''$

ALL DIMENSIONS ARE TYPICAL

## SUGGESTED INSTALLATION

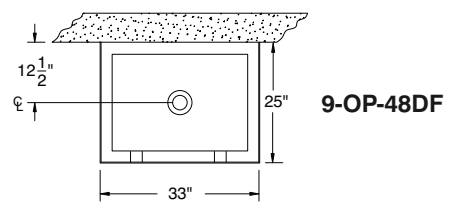
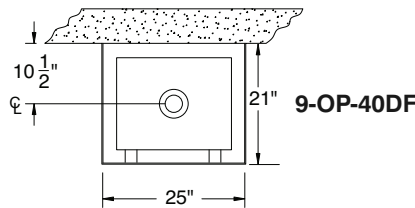


**9-OP-20:** 16" x 20" x 6" Bowl with 10" Overall Height. **Wt. 26 lbs.**

**9-OP-28:** 20" x 28" x 6" Bowl with 10" Overall Height. **Wt. 35 lbs.**

**9-OP-40:** 16" x 20" x 12" Bowl with 16" Overall Height. **Wt. 45 lbs.**

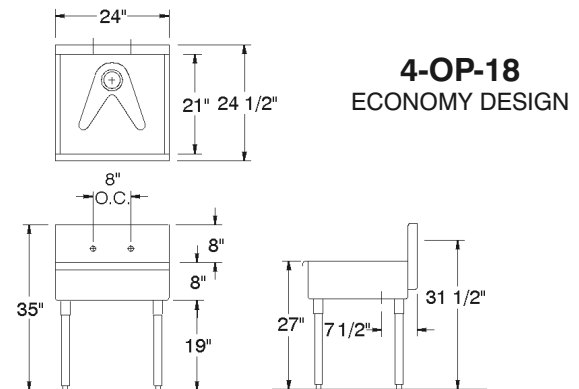
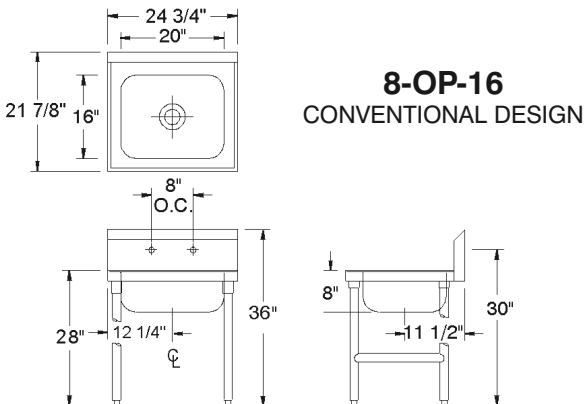
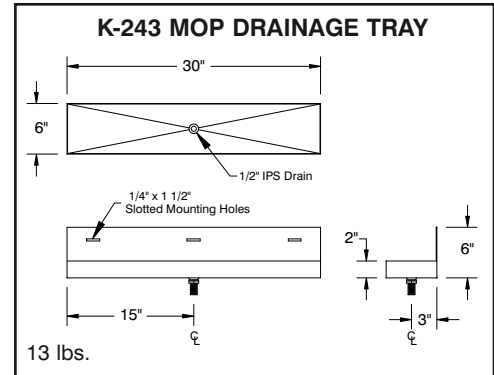
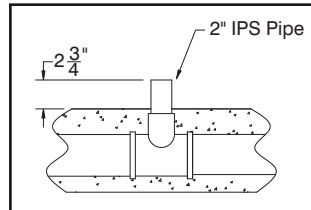
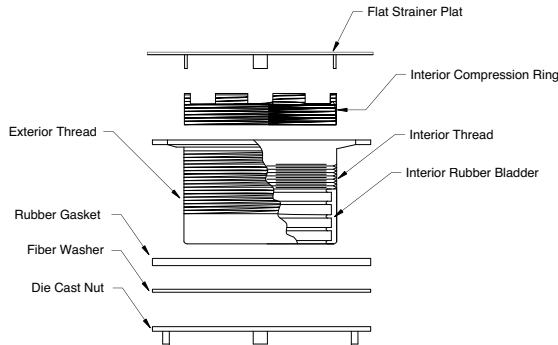
**9-OP-48:** 20" x 28" x 12" Bowl with 16" Overall Height. **Wt. 63 lbs.**



**9-OP-40DF:** 16" x 20" x 12" Bowl with 16" Overall Height. **Wt. 45 lbs.**

**9-OP-48DF:** 20" x 28" x 12" Bowl with 16" Overall Height. **Wt. 63 lbs.**

## MOP SINK DRAIN ASSEMBLY



1 1/2" IPS

8" Wide



**K-245 Shown**

Model #	Width	Length
<b>K-245</b>	<b>8"</b>	<b>24"</b>
<b>K-246</b>	<b>8"</b>	<b>36"</b>

Item #: \_\_\_\_\_ Qty #: \_\_\_\_\_

Model #: \_\_\_\_\_

Project #: \_\_\_\_\_

**FEATURES:**

Furnished with Mop Hangers and Hooks for hanging rags.  
Both rag hooks and mop hangers are spot welded to shelf.

**CONSTRUCTION:**

Shelf and brackets are die formed.

**MATERIAL:**

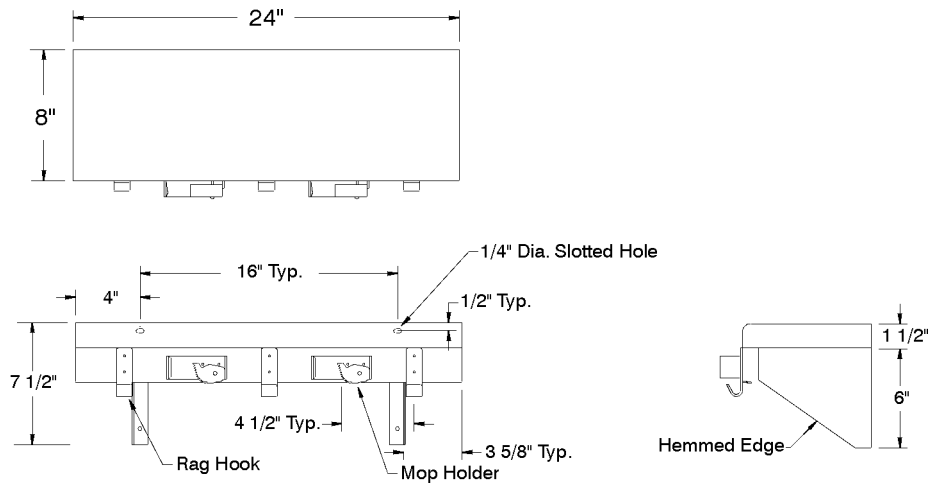
18 gauge stainless steel type "430" polished to a satin finish.

**DETAILS and SPECIFICATIONS**

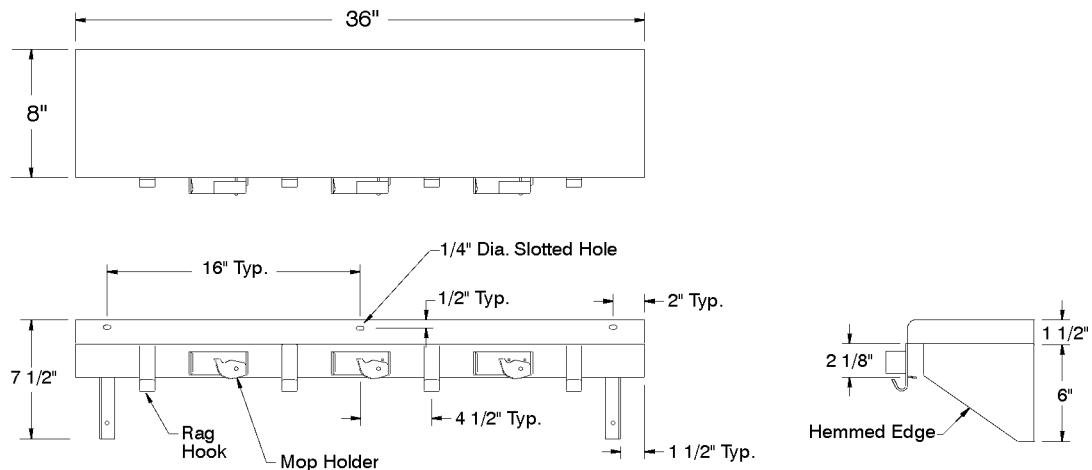
TOL ± .500"

ALL DIMENSIONS ARE TYPICAL

**K-245**



**K-246**



Customer Service Available To Assist You **1-800-645-3166** 8:30 am - 8:00 pm E.S.T.

Email Orders To: [customer@advancetabco.com](mailto:customer@advancetabco.com) For Smart Fabrication™ Quotes Email To: [smartfab@advancetabco.com](mailto:smartfab@advancetabco.com) or Fax To: 631-586-2023



# WaveBrake®

## COMPLETE MOPPING SYSTEMS

Provided by Owner; Cutsheet provided for design intent



# Complete Mopping Systems



## WAVEBRAKE® MOPPING SYSTEMS

WaveBrake® can handle any mopping job with ease, in sizes from 26 quart to the new 44 quart system.

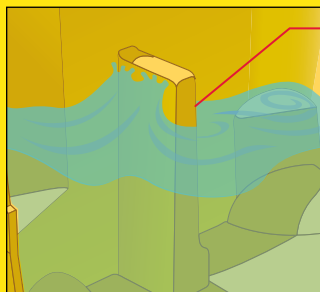
The famous patent-pending wave brake technology in every WaveBrake® bucket reduces splashing for a safer environment, cleaner floors, and more efficient mopping.

- CLEANER, EASIER MOPPING
- IMPROVED PRODUCTIVITY
- SAFER WORK ENVIRONMENT

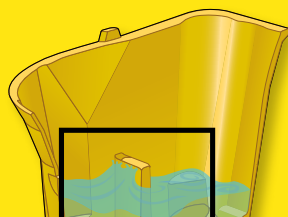
See it in ACTION  
[www.rubbermaidwavebrake.com](http://www.rubbermaidwavebrake.com)

### PROMOTE SAFE WORK PRACTICES

WaveBrake's® *innovative* bucket shape with patent-pending molded-in wave brakes reduces splashing up to 40% for safer mopping.



Molded-in wave brake



### DID YOU KNOW?

Slip, trip, and fall accidents cost U.S. businesses over \$100,000 (avg.) per lawsuit annually.

Source: Nat'l Floor Safety Institute (NFSI Database)



### PROTECT WORKER WELL-BEING

The WaveBrake® 44 Qt Mopping Combo includes an *innovative* foot pedal water release mechanism that helps reduce





## WAVEBRAKE® 26 QT MOPPING SYSTEM

WaveBrake® performance in a compact size.

- Works with all Rubbermaid Cleaning Carts
- Premium tubular steel and structural web molded plastic
- Full-size Side Press Wringer accepts all mop sizes\*



7480-18

\*Does not accept 9C74 Dirty Water Bucket.

## SIDE PRESS WRINGER



- Wring mops with 18% less effort
- Lasts over 58 times longer than comparable wringers\*
- Wringer handle is made from premium tubular steel and has a contoured comfort grip
- Wringer body is made from structural web molded plastic

\*Structural Web wringer is tested to exceed 50,000 wringing cycles. Average injection molded wringers perform approximately 860 cycles.

## TANDEM™ 31 QT BUCKET AND WRINGER COMBO

All-in-one compact design means no more lost parts.

- One-piece design with integrated bucket and wringer\*
- Built-in lift handles on bottom of bucket make lifting and emptying easy
- Works with all Rubbermaid Cleaning Carts
- Accepts up to 24 oz mops



## DOWN PRESS WRINGER



- Efficiently presses water down into bucket
- Wringer body is made from structural web molded plastic
- Wringing system preferred by floor techs



Fuller Middle School  
Framingham, MA

Item #: 2  
Quantity: 1

\*Do

# Smarter Mopping



6186-88



7570-88



7780



7571-88



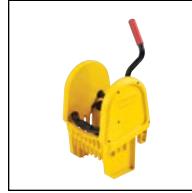
7680



6127-88



7580-88



7575-88



7480-18



9C74



7380



9C73\*

## WAVEBRAKE® 44 QT MOPPING COMBOS

No.	Description	Dimensions	Capacity	Ship Wt	Color	Pack
6186-88	44 Qt WaveBrake® Side Press Combo	26 <sup>3</sup> / <sub>4</sub> " l x 18 <sup>1</sup> / <sub>2</sub> " w x 38 <sup>3</sup> / <sub>4</sub> " h	44 qt	23.7 lbs	YEL	1
7576-88	44 Qt WaveBrake® Down Press Combo	26 <sup>3</sup> / <sub>4</sub> " l x 18 <sup>1</sup> / <sub>2</sub> " w x 38 <sup>3</sup> / <sub>4</sub> " h	44 qt	24.4 lbs	YEL	1

## WAVEBRAKE® 35 QT MOPPING TROLLEYS

No.	Description	Dimensions	Capacity	Ship Wt	Color	Pack
7780	35 Qt WaveBrake® Mopping Trolley Side Press	28 <sup>3</sup> / <sub>4</sub> " l x 18 <sup>1</sup> / <sub>2</sub> " w x 38 <sup>3</sup> / <sub>4</sub> " h	35 qt	38 lb	YEL	1
7777	35 Qt WaveBrake® Mopping Trolley Down Press	28 <sup>3</sup> / <sub>4</sub> " l x 18 <sup>1</sup> / <sub>2</sub> " w x 38 <sup>3</sup> / <sub>4</sub> " h	35 qt	41.1 lb	YEL, RED, BLUE, GRN	1

## WAVEBRAKE® 35 QT DUAL WATER MOPPING COMBOS

No.	Description	Dimensions	Capacity	Ship Wt	Color	Pack
7680	35 Qt WaveBrake® Dual Water Side Press Combo	22 <sup>3</sup> / <sub>4</sub> " l x 16 <sup>1</sup> / <sub>2</sub> " w x 38 <sup>3</sup> / <sub>4</sub> " h	35 qt	25.5 lb	YEL	1
7677	35 Qt WaveBrake® Dual Water Down Press Combo	22 <sup>3</sup> / <sub>4</sub> " l x 16 <sup>1</sup> / <sub>2</sub> " w x 38 <sup>3</sup> / <sub>4</sub> " h	35 qt	27.4 lb	YEL	1

## WAVEBRAKE® 35 QT MOPPING COMBOS

No.	Description	Dimensions	Capacity	Ship Wt	Color	Pack
7580-88	35 Qt WaveBrake® Side Press Combo	20 <sup>1</sup> / <sub>2</sub> " l x 15 <sup>3</sup> / <sub>4</sub> " w x 36 <sup>1</sup> / <sub>2</sub> " h	35 qt	19.5 lb	YEL, BRN	1
7577-88	35 Qt WaveBrake® Down Press Combo	20 <sup>1</sup> / <sub>2</sub> " l x 15 <sup>3</sup> / <sub>4</sub> " w x 36 <sup>1</sup> / <sub>2</sub> " h	35 qt	21.2 lb	YEL, BRN	1
7588-88	35 Qt WaveBrake® Side Press Combo	20 <sup>1</sup> / <sub>2</sub> " l x 15 <sup>3</sup> / <sub>4</sub> " w x 36 <sup>1</sup> / <sub>2</sub> " h	35 qt	19.5 lb	RED, GRN, BLUE	1
7578-88	35 Qt WaveBrake® Down Press Combo	20 <sup>1</sup> / <sub>2</sub> " l x 15 <sup>3</sup> / <sub>4</sub> " w x 36 <sup>1</sup> / <sub>2</sub> " h	35 qt	21.2 lb	RED, GRN, BLUE	1
7590-88	35 Qt WaveBrake® Institutional Combo	18 <sup>3</sup> / <sub>4</sub> " l x 15 <sup>3</sup> / <sub>4</sub> " w x 24 <sup>3</sup> / <sub>4</sub> " h	35 qt	14.2 lb	YEL	1

## WAVEBRAKE® BUCKETS

No.	Description	Dimensions	Capacity	Ship Wt	Color	Pack
7470	Bucket with Caster Kit	18.6" l x 15.9" w x 16.7" h	26 qt	37.1 lb	YEL	4
7570-88	Bucket with Caster Kit	20.1" l x 16" w x 17.4" h	35 qt	40.1 lb	BLUE <sup>a</sup> , BRN, GRN <sup>a</sup> , RED <sup>a</sup> , YEL	4
7571-88	Bucket no Casters	20.1" l x 16" w x 16" h	35 qt	35.6 lb	YEL, RED, GRN, BLUE	4

<sup>a</sup> Requires 4 weeks lead time and are non-returnable.

## WAVEBRAKE® WRINGERS

No.	Description	Dimensions	Mop Capacity	Ship Wt	Color	Pack
6127-88*	Side Press Wringer for WaveBrake®	13" l x 13" w x 27" h	12-32 oz	19.5 lb	BLUE <sup>a</sup> , BRN, GRN <sup>a</sup> , RED <sup>a</sup> , YEL	2
7575-88†	Down Press Wringer for WaveBrake®	13.5" l x 13.2" w x 27" h	16-32 oz	22.1 lb	YEL, RED, GRN, BLUE	2

<sup>a</sup> Requires 4 weeks lead time and are non-returnable.

\* Fits 7570, 7571, & 7470 WaveBrake® Buckets

† Fits 7570 & 7571 WaveBrake® Buckets

## WAVEBRAKE® ACCESSORIES

No.	Description	Dimensions	Capacity	Ship Wt	Color	Pack
9C74	Dirty Water Bucket for WaveBrake®	14.1" l x 9.9" w x 14.1" h	18 qt	17 lb	RED, YEL	6
9C73	Quiet Caster Dolly*	22.4" l x 16.5" w x 6.2" h	N/A	10.1 lb	BLA	1

\* For use with 35 Qt WaveBrake® Systems only.

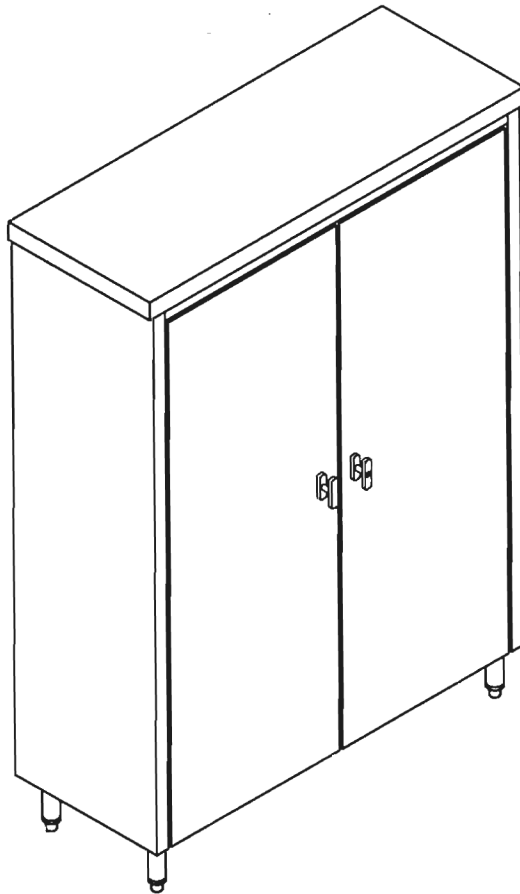
## WAVEBRAKE® 26 QT MOPPING COMBO

No.	Description	Dimensions	Capacity	Ship Wt	Color	Pack
7480-18 <sup>b</sup>	26 Qt WaveBrake® Side Press Combo	18 <sup>3</sup> / <sub>4</sub> " l x 15 <sup>3</sup> / <sub>4</sub> " w x 16 <sup>3</sup> / <sub>4</sub> " h	26 Qt	23.7 lbs	YEL	12 Pcs/ 1 Pallet

<sup>b</sup>Pallet Pack

## TANDEM™ 31 QT BUCKET & WRINGER COMBO

No.	Description	Dimensions	Capacity	Ship Wt	Color	Pack
7380	31 Qt Tandem™ Bucket & Wringer Combo	22 <sup>3</sup> / <sub>4</sub> " l x 13 <sup>3</sup> / <sub>4</sub> " w x 32 <sup>1</sup> / <sub>4</sub> " h	31 qt	11.8 lb	YEL	1



## **CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION:** Detergent storage cabinet

36" x 18" x 72" high

**NO CUT SHEET AVAILABLE**

### **CONSTRUCTION FEATURES:**

- 16 gauge stainless steel top with edges turned down
- 18 gauge stainless steel cabinet body
- Fixed bottom shelf
- Three adjustable intermediate shelves
- 63" high double pan hinged doors at front
- Mount on 6" high stainless steel adjustable legs
- Two (2) three point "T" handles, one locking
- Barrel bolts mounted to inside top and bottom of door

## Welded and Unassembled Lockers

1. **Heavy-Duty Frame and Door**  
Welded frame and door is constructed of 16-gauge steel for added rigidity.
2. **Door Stiffeners\***  
Steel door reinforcements add rigidity and dampen noise.
3. **Locking Bar\***  
Steel locking bar offers strength, while spring actuated latches provide secure and quiet latch operation.
4. **Double Leaf Five-Knuckle Hinge**  
Extra-strong five-knuckle hinge with secured pin offers security, easy operation and long life.
5. **Available Welded**  
Electric resistance welded housing for added strength and cleaner appearance.
6. **Available Unassembled**  
Knock down version saves on shipping costs.
7. **Recessed Handle\***  
Inset handle design allows padlocks to be recessed rather than protruding into aisles, increasing vandal-resistance.
8. **Shelf Design**  
Triple bend on front flange for added safety.
9. **Hat Shelf\***  
Handy shelf for personal storage of hats, gloves, toiletries, books, etc. Available on Single Tier Lockers only.
10. **Louvers**  
Full width, contemporary styled louvers at top and bottom. Number of louvers increase with door width for improved ventilation of larger locker sizes.
11. **Rubber Bumpers**  
Door closing noise is effectively dampened with carefully placed bumpers.
12. **Choice of Leg Options**  
Lockers available with or without legs. Optional front- and end-bases available to enclose base. Use a closed base for lockers without legs.
13. **Durable Finish & Large Color Selection**  
Tough, powder-coated finish keeps its good looks for years. Colors are available to complement any setting.



## DOUBLE TIER LOCKERS



Double Tier Lockers feature two openings per locker, giving you twice as many lockers in the same space as single tier, yet providing plenty of hanging room for shirts and jackets. Perfect for the gym.

- Opening widths of 12" or 15"\*
- Locker depths of 12", 15" or 18"\*
- Available in single or three-wide units
- Available welded or unassembled
- Three coat hooks per opening
- Positive 2 point locking system on doors
- Available with or without legs
- Three wide units with legs use four rear legs for support
- Flush louvers for ventilation
- Door stiffeners add rigidity
- Doors available in a variety of styles including standard, ventilated and C-Thru
- Optional locks and other accessories available, refer to pages 26-30

\*Refer to price list for specific combinations.

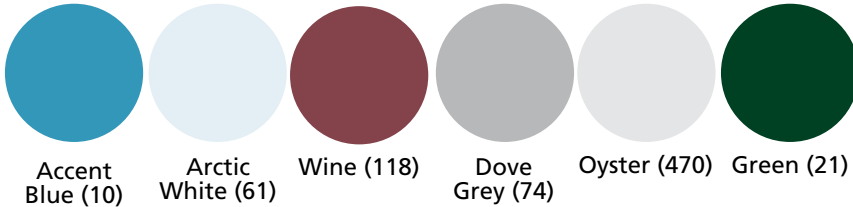


All Tennsco Steel Lockers are electrostatically painted with a tough, long lasting powder finish to ensure years of lasting beauty. Choose from five standard finishes.

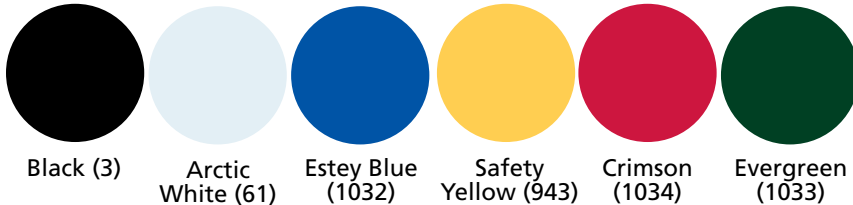
**Standard Locker Colors**



**Premium Locker Colors**



**Cubby Colors**



Standard Colors are available at no additional charge. Premium and Special Matched Colors are available for an upcharge. Finishes shown above are representative of the actual finishes. Please contact your local Tennsco dealer for more precise color swatches.

**A WORD ABOUT TENNSCO**

Tennsco Corp., headquartered in Dickson, Tennessee, began operations in 1962. Today, Tennsco is an industry leader with over 1.6 million square feet in eight facilities. Tennsco offers a wide variety of storage and filing systems, steel office furniture, industrial and institutional shelving, lockers and shop equipment.

**ENVIRONMENTALLY FRIENDLY PRODUCTS**

Tennsco steel products are certified SCS Indoor Advantage Gold for indoor air quality and low VOC emissions.



Tennsco products allow our customers to apply for LEED™ credits as described below:

- a. MR Credit 4.1 and 4.2 – Recycled Content
- b. MR Credit 5.1 – Manufactured Regionally
- c. MR Credit 5.2 – Extracted and Manufactured Regionally
- d. EQ Credit 4.2 – Low Emitting Materials, Paints



Mailing Address: P.O. Box 1888, Dickson, TN 37056-1888

Shipping Address: 201 Tennsco Drive, Dickson, TN 37055



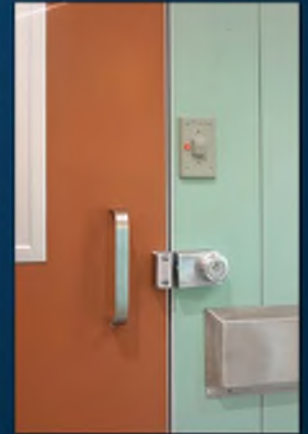
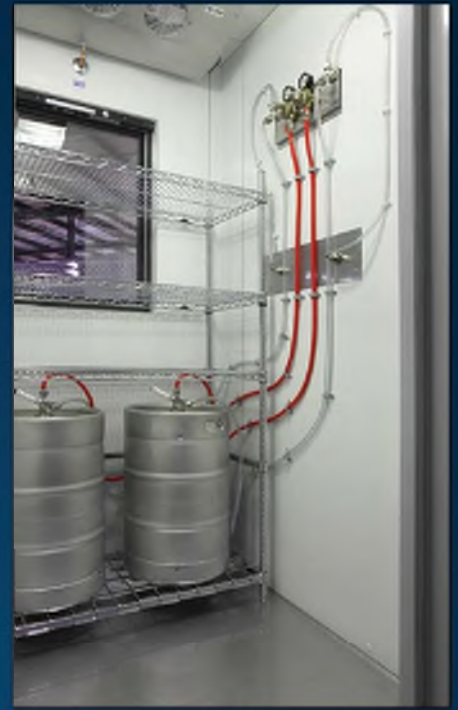
**Fuller Middle School**  
Framingham, MA

Item #: 2  
Quantity: 3

**Quality you can depend on...**

**from the inside out.™**







For half of a century American Panel Corporation has been dedicated to satisfying the cold storage needs of the industry's most demanding customers. Our attention to superior quality, product versatility and customer service remains unequalled today. Ever poised for an even deeper commitment to our industry - we are committed to the continuing development of state-of-the-art foamed-in-place walk-in coolers and freezers.

**High Efficiency**

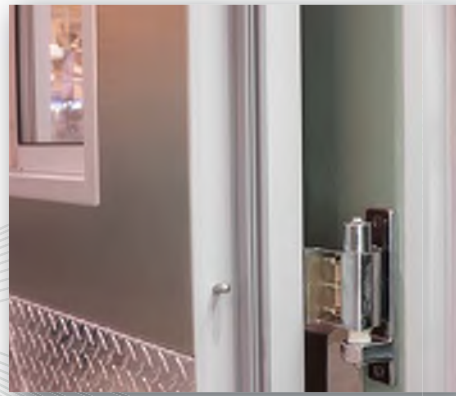
Our foamed-in-place urethane is the ultimate insulating material currently available for walk-in construction. Operating costs are significantly reduced as a result of the high insulating values of panels manufactured with urethane insulation. Other desirable properties include structural rigidity, dimensional stability, uniform density and compliance with nationally accepted building codes.

**Outstanding Value**

Considering the thoughtful design, efficient manufacturing process, skilled craftsmanship, advanced features and customer support, you simply cannot find a better walk-in value than American Panel.

**Lasting Durability**

Space age materials like our fiberglass reinforced polymer (FRP) door perimeter and frame are used to protect your investment for years to come. This FRP is a corrosion proof, impact resistant, non-conductive material that will not absorb moisture. Moreover, it is superior to steel, vinyl, wood or other commonly used door and frame materials.



*Cam Lock & Floor Screenshot*



**Reliable Performance**

Choose from our complete selection of high performance refrigeration equipment and accessories for the most efficient and reliable installation possible. Our quality-engineered remote, remote quick connect, pre-assembled remote or top/side quick connect self-contained units are available for any indoor or outdoor application.

**Insulation**

American Panel insulated panels are 4" thick high pressure impingement mixed (HPIM), foamed-in-place urethane



**Fuller Middle School**  
Framingham, MA

Item #: 08  
Quantity: 1

## Exceptional Appearance

Top quality commercial hardware, premium grade metal finishes and attention to manufacturing detail contribute to the overall appearance of the finished product. Whether used indoor or outdoor, for display purposes or general kitchen applications, American Panel walk-ins are always aesthetically pleasing.

## Superior Strength

Optional heavy duty flooring is also available. This heavy-duty structural flooring can support up to 15,000 pounds per square foot (static load) as tested in accordance with ASTM Standards.



## Ultimate Flexibility

Every American Panel walk-in is equipped with a full complement of standard accessories designed to meet the needs of a broad range of end users. However, depending on your particular requirements, you may wish to include additional options and features. We can provide every item for even the most sophisticated of applications.



## Consistent Quality

Ours is perhaps the most thoroughly scrutinized production process in the industry. Our dedication to zero defect manufacturing and product



Fuller Middle School  
Framingham, MA

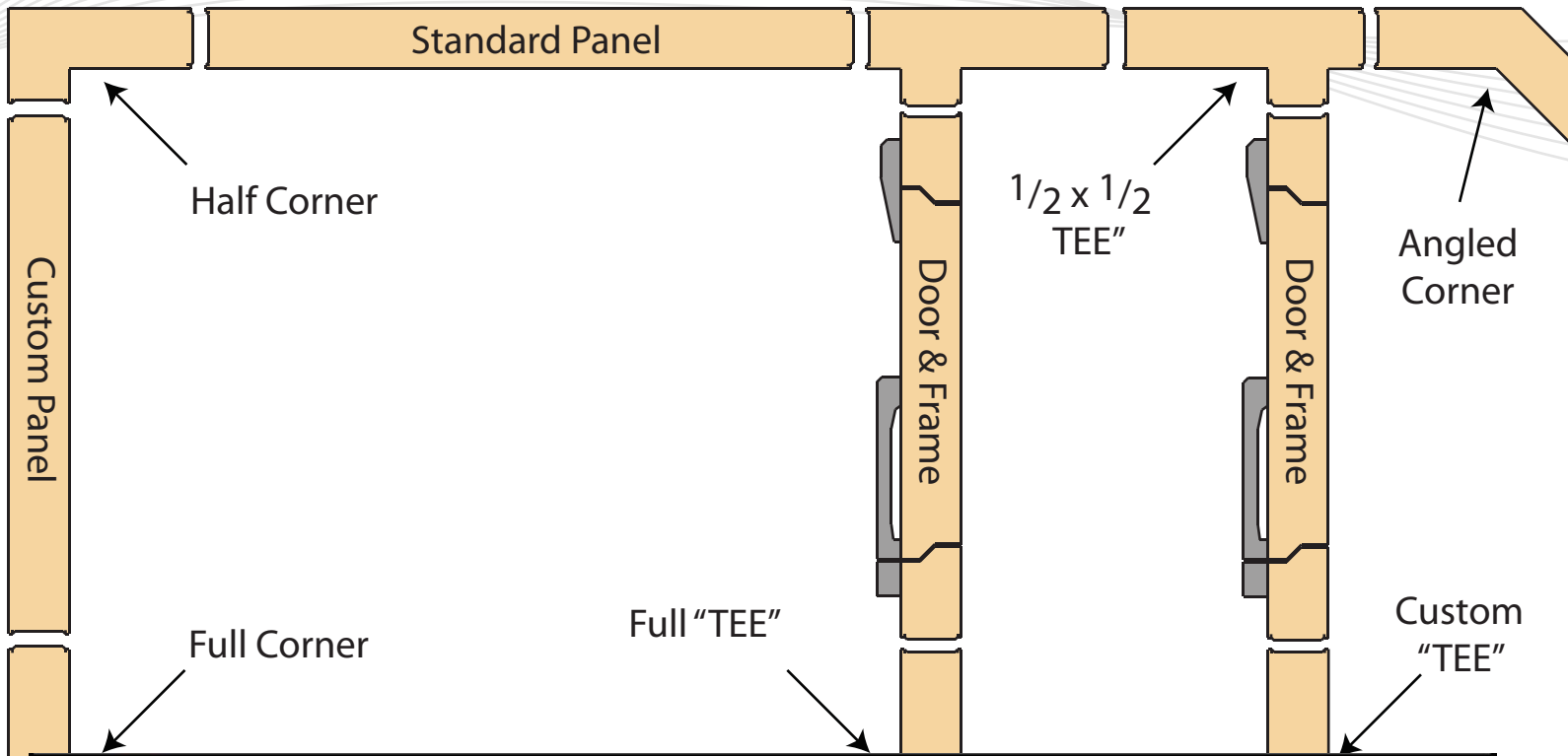
Item #: 08  
Quantity: 1



**State of the Art Machinery**

State of the art machinery allows for the highest degree of precision. In the picture above, a worker uses an automated punch press to create the outer skin for a wall panel. Each piece of sheet metal is programmed by an engineer and then fed to the machinery on the factory floor.

At right, a worker uses a highly accurate computer controlled bend press to form the double 90° bends. These bends will form the perimeter of the panel and help to hold the metal to the foam within the panel. They also serve as an anchor point for the tear-drop gasket that forms the airtight seal on the walk-in.



**Fuller Middle School**  
Framingham, MA

Item #: 08  
Quantity: 1

Cus

## Functional Design

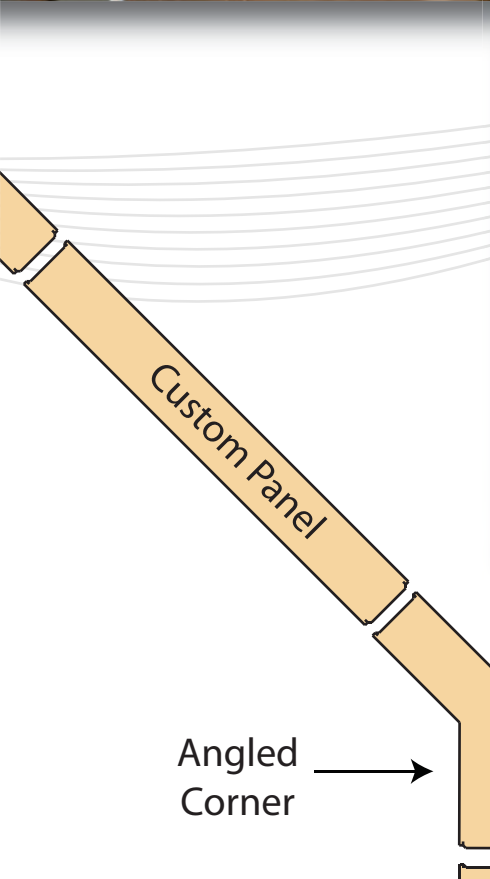
Virtually any cold storage requirement can be met using American Panel walk-ins. Restaurants, hospitality, correctional, healthcare, scientific, industrial, educational and large venues all have highly specialized needs. Rather than over-sell or under-sell our desire is to provide equipment that exactly matches the job at hand. Experienced sales and engineering personnel are at your disposal to assist in the design of your next project no matter how large or small the project or specialized the application.



## Monitoring Systems

Along with our high-tech manufacturing processes American Panel is on the cutting edge with the proprietary System 100 monitoring system that comes standard on every room. High and low alarm set points coupled with an audio/visual alert ensure your food product is safe and sound.

Additional options and systems are available to add features like battery backups, multi-compartment monitoring, PC connections and much, much more.



## Modular Design Flexibility

Our modular panel system is the most comprehensive in existence, giving you the greatest degree of design flexibility possible. The system has evolved out of an industry-wide need for a more versatile array of standard panel sizes to maximize the amount of cold storage space.

The standard overall height for walk-ins with floors is 7'-6". Additional



Fuller Middle School  
Framingham, MA

Item #: 08  
Quantity: 1



# SmartVap II

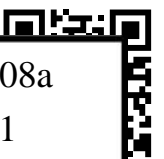
Electronically Controlled System II<sup>®</sup>

THE ULTIMATE ELECTRIC DEFROST UNIT COOLER  
2 PIPES + 2 WIRES = SIMPLE



Fuller Middle School  
Framingham, MA

Item #: 08a  
Quantity: 1





### SmartVap II Defrost Units

#### IT'S SMART

- Electronically Controls:
- Box Temperature
- Defrost Initiation
- Defrost Termination
- Fan Delay

#### IT'S SIMPLE

- 2 Pipes, 2 Wires, It's Done!
- Eliminates wiring back to condensing unit
- Factory Pre-set to suit most applications
- Simple user interface

#### EVAPORATOR INCLUDES FACTORY INSTALLED:

- Selected Nozzle
- Thermostatic Expansion Valve
- Solenoid Valve
- Disconnect Switch (optional)

Bally has taken the concept of electronic controls and made it simple. SmartVap II™ is a simple control located in the evaporator that controls box temperature and all aspects of the electric defrost.

By eliminating the time clock and heater contactor usually located in the condensing unit, the SmartVap II™ makes wiring the refrigeration system a breeze.

#### PLUS

As an electronic controller, SmartVap II™ allows for more accurate temperature control in the box.

SmartVap II™ is field adjustable for unique applications, and has a user lock option that will prevent unauthorized adjustments to settings.

### SmartVap II™ Controller replaces these components:



Time Clock



Room Thermostat



Defrost Heater Contactor



Defrost Heater Fusing



Defrost Termination/  
Fan Delay Thermostat



### BQ-Line Quiet Condensing Units

- 1 - 6 HP HIGH/MED. TEMP (0°F - +40°F SST) R404A/R407C
- 1 - 6 HP LOW TEMP (-40°F - 0°F) R404A
- LOW AMBIENT OPERATION (AS LOW AS -35°F)
- 208-230/1/60, 208-230/3/60, 460/3/60

#### TESTING RESULTS SHOW...

- Sound levels are approx 15 dBA lower than conventional style condensing units at 70°F (full speed)
- Sound levels are approx 20 dBA lower than conventional condensing units below 70°F (lower speed)
- Save up to 25% on energy costs\*
- Head pressure and stable liquid temperature to the TXV maintained to ensure optimal TXV performances

#### DESIGN HIGHLIGHTS

- Quiet Operation
- High Efficiency
- Compact Design
- Minimal Product Footprint
- Optional Wall Mounting Kit
- Copeland or Tecumseh Compressors
- Scroll and Hermetic Compressor Models Available

#### VARIABLE SPEED EC MOTORS (STANDARD) PROVIDE...

- Energy Savings Through Speed Reduction
- Reduced Sound Levels
- Low Refrigerant Charge Due To No Flooding Valve

How Quiet is the  
Bally Quiet Unit?



\* Dependent upon numerous factors, please refer to product documentation for complete details



Fuller Middle School  
Framingham, MA

Item #: 08a  
Quantity: 1



# QUIETUNIT

REFRIGERATION DUTY CONDENSING UNITS



**SCROLL COMPRESSORS**

**ENERGY EFFICIENT**

**COMPACT**

**AWARD WINNING**



Fuller Middle School  
Framingham, MA

Item #: 08b  
Quantity: 1





## BQ-Line Quiet Condensing Units

### DESIGN HIGHLIGHTS

- Quiet Operation
- High Efficiency
- Compact Design
- Minimal Product Footprint
- Optional Wall Mounting Kit
- Copeland Scroll Compressors



- 1 - 6 HP high/med. Temp (0°F - +40°F SST) R407A/R407C
- 1 - 6 HP low temp (-40°F - 0°F) R404A
- Low ambient operation (as low as -35°F)
- 208-230/1/60, 208-230/3/60, 460/3/60

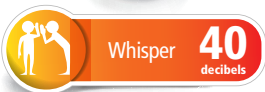
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- Save up to 25% on energy costs\*
- Head pressure and stable liquid temperature to the TXV maintained to ensure optimal TXV performances

### VARIABLE SPEED EC MOTORS (STANDARD) PROVIDE...

- Energy Savings Through Speed Reduction
- Reduced Sound Levels
- Low Refrigerant Charge Due To No Flooding Valve

How Quiet is the  
Bally Quiet Unit?



## CHECK OUT OUR VIDEOS



Watch our video to learn more about the versatility and convenience of Bally's Quiet Unit.

Scan the QR Code with your smartphone.

Or visit: [b-rp.ca/quietunit](http://b-rp.ca/quietunit)



\* Dependent upon numerous factors, please refer to product documentation for complete details



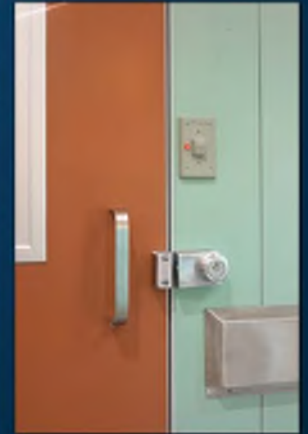
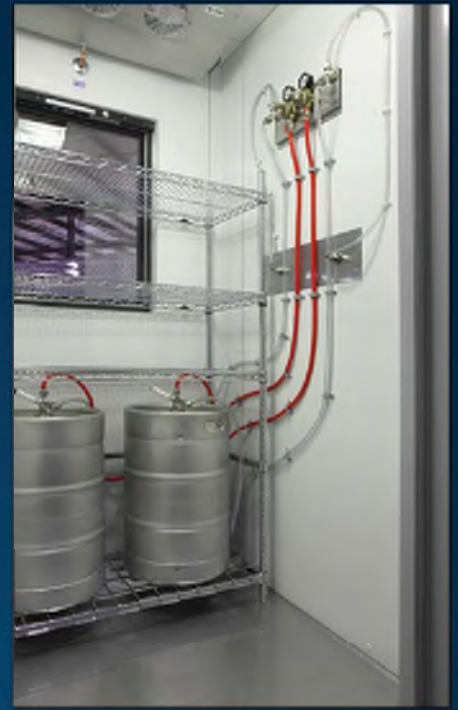
Fuller Middle School  
Framingham, MA

Item #: 08b  
Quantity: 1

**Quality you can depend on...**

**from the inside out.™**





For half of a century American Panel Corporation has been dedicated to satisfying the cold storage needs of the industry's most demanding customers. Our attention to superior quality, product versatility and customer service remains unequalled today. Ever poised for an even deeper commitment to our industry - we are committed to the continuing development of state-of-the-art foamed-in-place walk-in coolers and freezers.

**High Efficiency**

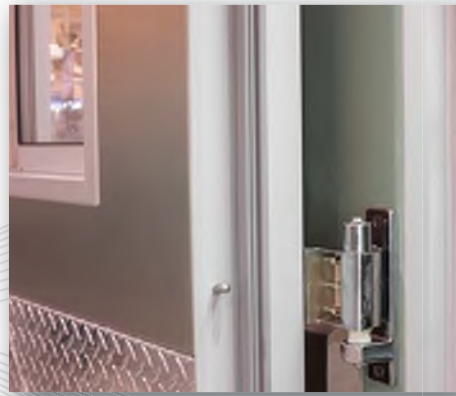
Our foamed-in-place urethane is the ultimate insulating material currently available for walk-in construction. Operating costs are significantly reduced as a result of the high insulating values of panels manufactured with urethane insulation. Other desirable properties include structural rigidity, dimensional stability, uniform density and compliance with nationally accepted building codes.

**Outstanding Value**

Considering the thoughtful design, efficient manufacturing process, skilled craftsmanship, advanced features and customer support, you simply cannot find a better walk-in value than American Panel.

**Lasting Durability**

Space age materials like our fiberglass reinforced polymer (FRP) door perimeter and frame are used to protect your investment for years to come. This FRP is a corrosion proof, impact resistant, non-conductive material that will not absorb moisture. Moreover, it is superior to steel, vinyl, wood or other commonly used door and frame materials.



*Cam Lock & Floor Screenshot*



**Reliable Performance**

Choose from our complete selection of high performance refrigeration equipment and accessories for the most efficient and reliable installation possible. Our quality-engineered remote, remote quick connect, pre-assembled remote or top/side quick connect self-contained units are available for any indoor or outdoor application.

**Insulation**

American Panel insulated panels are 4" thick high pressure impingement mixed (HPIM), foamed-in-place urethane



**Fuller Middle School**  
Framingham, MA

Item #: 09  
Quantity: 1

## Exceptional Appearance

Top quality commercial hardware, premium grade metal finishes and attention to manufacturing detail contribute to the overall appearance of the finished product. Whether used indoor or outdoor, for display purposes or general kitchen applications, American Panel walk-ins are always aesthetically pleasing.

## Superior Strength

Optional heavy duty flooring is also available. This heavy-duty structural flooring can support up to 15,000 pounds per square foot (static load) as tested in accordance with ASTM Standards.



## Ultimate Flexibility

Every American Panel walk-in is equipped with a full complement of standard accessories designed to meet the needs of a broad range of end users. However, depending on your particular requirements, you may wish to include additional options and features. We can provide every item for even the most sophisticated of applications.



## Consistent Quality

Ours is perhaps the most thoroughly scrutinized production process in the industry. Our dedication to zero defect manufacturing and product



Fuller Middle School  
Framingham, MA

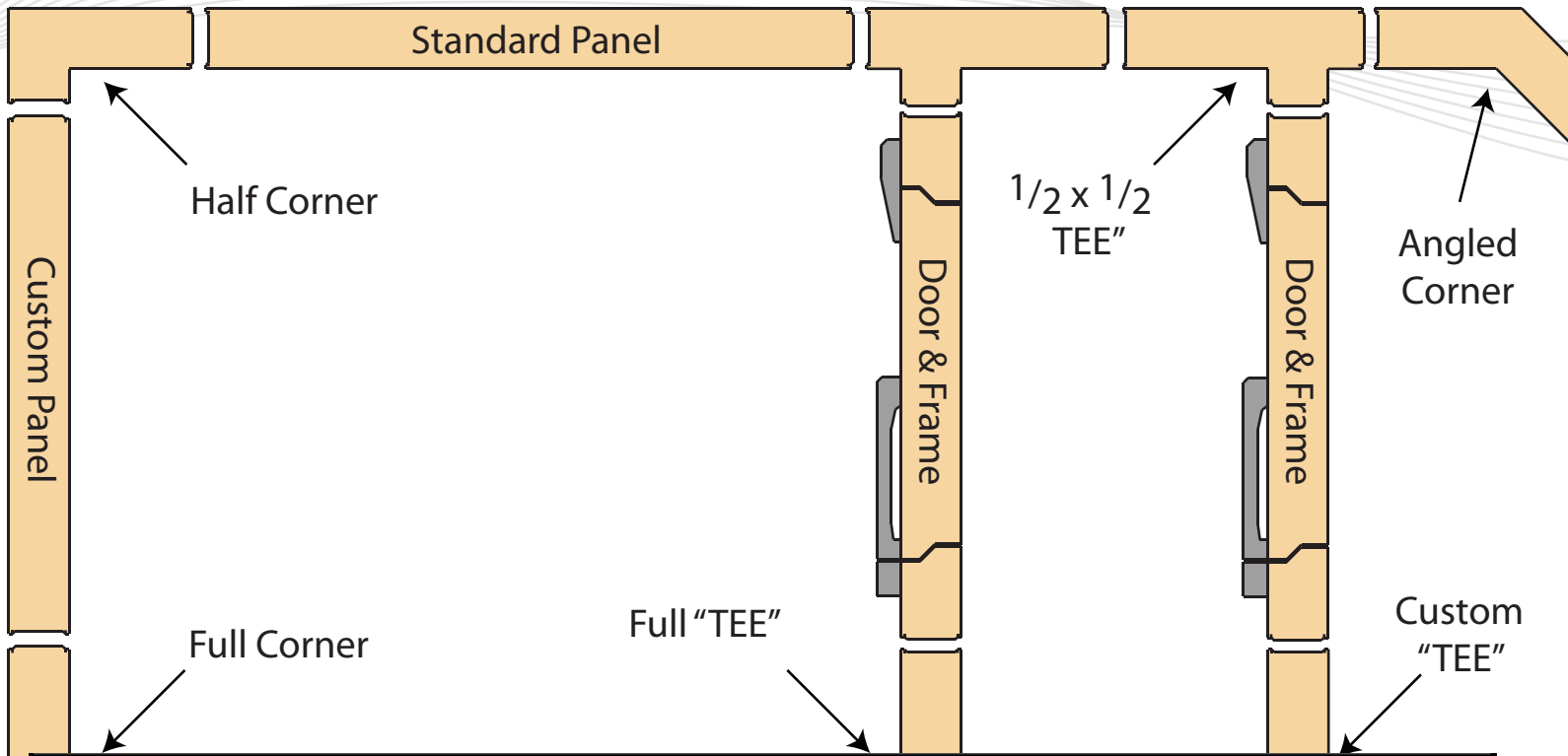
Item #: 09  
Quantity: 1



**State of the Art Machinery**

State of the art machinery allows for the highest degree of precision. In the picture above, a worker uses an automated punch press to create the outer skin for a wall panel. Each piece of sheet metal is programmed by an engineer and then fed to the machinery on the factory floor.

At right, a worker uses a highly accurate computer controlled bend press to form the double 90° bends. These bends will form the perimeter of the panel and help to hold the metal to the foam within the panel. They also serve as an anchor point for the tear-drop gasket that forms the airtight seal on the walk-in.



**Fuller Middle School**  
Framingham, MA

Item #: 09  
Quantity: 1

Cus

## Functional Design

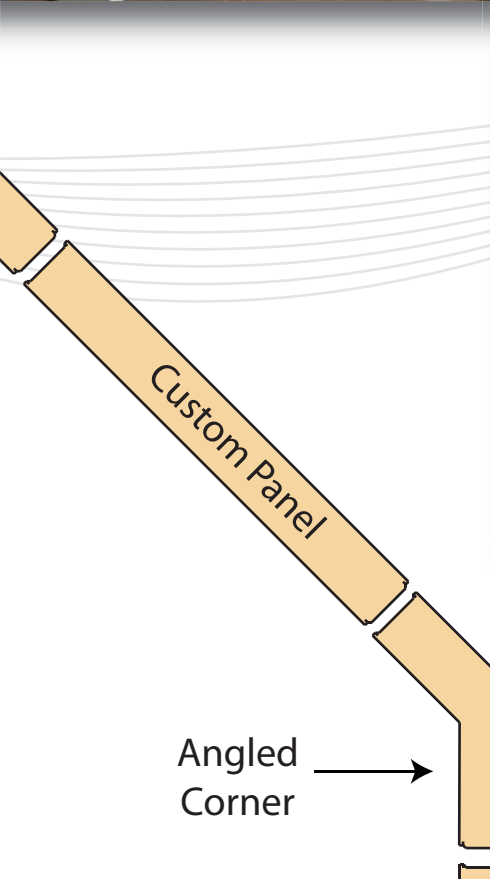
Virtually any cold storage requirement can be met using American Panel walk-ins. Restaurants, hospitality, correctional, healthcare, scientific, industrial, educational and large venues all have highly specialized needs. Rather than over-sell or under-sell our desire is to provide equipment that exactly matches the job at hand. Experienced sales and engineering personnel are at your disposal to assist in the design of your next project no matter how large or small the project or specialized the application.



## Monitoring Systems

Along with our high-tech manufacturing processes American Panel is on the cutting edge with the proprietary System 100 monitoring system that comes standard on every room. High and low alarm set points coupled with an audio/visual alert ensure your food product is safe and sound.

Additional options and systems are available to add features like battery backups, multi-compartment monitoring, PC connections and much, much more.



## Modular Design Flexibility

Our modular panel system is the most comprehensive in existence, giving you the greatest degree of design flexibility possible. The system has evolved out of an industry-wide need for a more versatile array of standard panel sizes to maximize the amount of cold storage space.

The standard overall height for walk-ins with floors is 7'-6". Additional



Fuller Middle School  
Framingham, MA

Item #: 09  
Quantity: 1



# SmartVap II

Electronically Controlled System II<sup>®</sup>

THE ULTIMATE ELECTRIC DEFROST UNIT COOLER  
2 PIPES + 2 WIRES = SIMPLE



Fuller Middle School  
Framingham, MA

Item #: 09a  
Quantity: 1







## SmartVap II Defrost Units

### IT'S SMART

- Electronically Controls:
- Box Temperature
- Defrost Initiation
- Defrost Termination
- Fan Delay

### IT'S SIMPLE

- 2 Pipes, 2 Wires, It's Done!
- Eliminates wiring back to condensing unit
- Factory Pre-set to suit most applications
- Simple user interface

### EVAPORATOR INCLUDES FACTORY INSTALLED:

- Selected Nozzle
- Thermostatic Expansion Valve
- Solenoid Valve
- Disconnect Switch (optional)

Bally has taken the concept of electronic controls and made it simple. SmartVap II™ is a simple control located in the evaporator that controls box temperature and all aspects of the electric defrost.

By eliminating the time clock and heater contactor usually located in the condensing unit, the SmartVap II™ makes wiring the refrigeration system a breeze.

### PLUS

As an electronic controller, SmartVap II™ allows for more accurate temperature control in the box.

SmartVap II™ is field adjustable for unique applications, and has a user lock option that will prevent unauthorized adjustments to settings.

### SmartVap II™ Controller replaces these components:



Time Clock



Room Thermostat



Defrost Heater Contactor



Defrost Heater Fusing



Defrost Termination/  
Fan Delay Thermostat



### BQ-Line Quiet Condensing Units

- 1 - 6 HP HIGH/MED. TEMP (0°F - +40°F SST) R404A/R407C
- 1 - 6 HP LOW TEMP (-40°F - 0°F) R404A
- LOW AMBIENT OPERATION (AS LOW AS -35°F)
- 208-230/1/60, 208-230/3/60, 460/3/60

### TESTING RESULTS SHOW...

- Sound levels are approx 15 dBA lower than conventional style condensing units at 70°F (full speed)
- Sound levels are approx 20 dBA lower than conventional condensing units below 70°F (lower speed)
- Save up to 25% on energy costs\*
- Head pressure and stable liquid temperature to the TXV maintained to ensure optimal TXV performances

### DESIGN HIGHLIGHTS

- Quiet Operation
- High Efficiency
- Compact Design
- Minimal Product Footprint
- Optional Wall Mounting Kit
- Copeland or Tecumseh Compressors
- Scroll and Hermetic Compressor Models Available

### VARIABLE SPEED EC MOTORS (STANDARD) PROVIDE...

- Energy Savings Through Speed Reduction
- Reduced Sound Levels
- Low Refrigerant Charge Due To No Flooding Valve

## How Quiet is the Bally Quiet Unit?



Dog Barking **75** decibels

2HP Scroll Conventional Unit\* **71** decibels

Normal Conversation **65** decibels

Electric Razor **60** decibels

2HP Scroll Quiet Unit\* **55** decibels

Whisper **40** decibels

\* Dependent upon numerous factors, please refer to product documentation for complete details



Fuller Middle School  
Framingham, MA

Item #: 09a  
Quantity: 1



# QUIETUNIT

REFRIGERATION DUTY CONDENSING UNITS



**SCROLL COMPRESSORS**

**ENERGY EFFICIENT**

**COMPACT**

**AWARD WINNING**



Fuller Middle School  
Framingham, MA

Item #: 09b  
Quantity: 1



## BQ-Line Quiet Condensing Units

### DESIGN HIGHLIGHTS

- Quiet Operation
- High Efficiency
- Compact Design
- Minimal Product Footprint
- Optional Wall Mounting Kit
- Copeland Scroll Compressors



- 1 - 6 HP high/med. Temp (0°F - +40°F SST) R407A/R407C
- 1 - 6 HP low temp (-40°F - 0°F) R404A
- Low ambient operation (as low as -35°F)
- 208-230/1/60, 208-230/3/60, 460/3/60

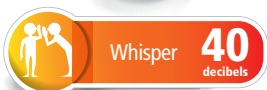
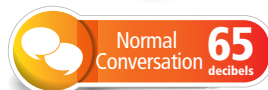
### TESTING RESULTS SHOW...

- Sound levels are approx 15 dBA lower than conventional style condensing units at 70°F (full speed)
- Sound levels are approx 20 dBA lower than conventional condensing units below 70°F (lower speed)
- Save up to 25% on energy costs\*
- Head pressure and stable liquid temperature to the TXV maintained to ensure optimal TXV performances

### VARIABLE SPEED EC MOTORS (STANDARD) PROVIDE...

- Energy Savings Through Speed Reduction
- Reduced Sound Levels
- Low Refrigerant Charge Due To No Flooding Valve

How Quiet is the  
Bally Quiet Unit?



## CHECK OUT OUR VIDEOS



Watch our video to learn more about the versatility and convenience of Bally's Quiet Unit.

Scan the QR Code with your smartphone.

Or visit: [b-rp.ca/quietunit](http://b-rp.ca/quietunit)



\* Dependent upon numerous factors, please refer to product documentation for complete details



Fuller Middle School  
Framingham, MA

Item #: 09b  
Quantity: 1

Item No. \_\_\_\_\_

Quantity \_\_\_\_\_

Job Name \_\_\_\_\_

Spec No. \_\_\_\_\_

### Box Transport Truck

ALUMINUM CONSTRUCTION

**Material:**

Hi-tensile, corrosion resistant, rust proof, primary extruded aluminum, Type 663- T5 alloy.

**Construction:**

All heli-arc welded all sealed (no rivets).

**Base:**

Perimeter frame of 1-1/2" x 1-1/2" x .070 wall extruded aluminum tube with 1-1/2" x 1-1/2" laterals welded at 3-7/8" intervals.

**Uprights:**

1-1/2" x 1-1/2" x .070 wall extruded aluminum tube with horizontal braces of 1-1/2" x 1-1/2" wall extruded tubing and welded securely to the base.

**Upper Shelf:**

Frame length consists of 1-1/2" x 1-1/2" aluminum tube and frame width consists of 1-1/2" x 1-1/2" aluminum tube with 1-1/2" x 1-1/2" aluminum tube laterals welded to length of frame on 3-7/8" intervals.

**Casters:**

Four platform type 5" casters, two rigid and two swivel with brake... all with ball bearing axle, and non-marking wheel.

### Mobile Dunnage Dolly

ALUMINUM CONSTRUCTION

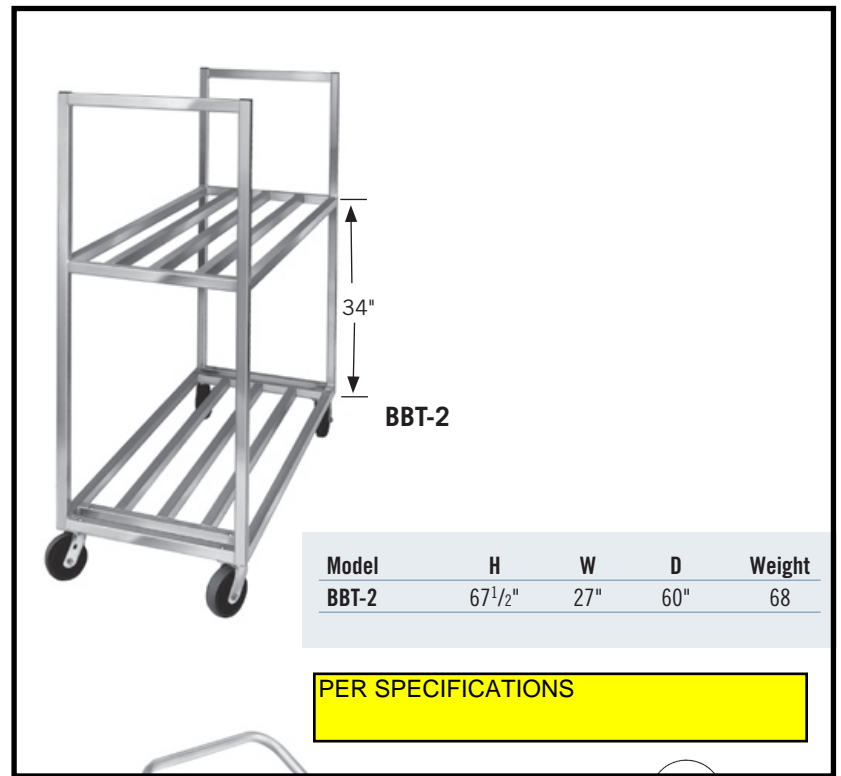
**Specifications:**

- 5" X 1-1/4" heavy duty plate casters for extra strength
- 1200 lbs. distributed weight capacity

**Options:**

Corner Bumpers /024

*Other Options Available*



Model	H	W	L	Weight
MD2036CA	8"	36"	20"	31
MD2048CA	8"	48"	20"	33
MD2060CA	8"	60"	20"	36
MD2436CA	8"	36"	24"	32
MD2448CA	8"	48"	24"	34
MD2460CA	8"	60"	24"	37

Custom Sizes Available

SOLID TOP				
Model	H	W	L	Weight
AD2428	8"	28"	24"	23
AD2433	8"	33"	24"	27
AD2440	8"	40"	24"	32



55 Channel Drive • Port Washington, NY 11050-2216  
 8891 NW 102nd Street • Medley, FL 33178  
 Tel: 516-944-6271 • Fax: 516-944-0625 • Toll Free: 866-712-7283  
 www.channelmfg.com • Email: sales@channelmfg.com



Fuller Middle School  
 Framingham, MA

Item #: 10  
 Quantity: 6



**InterMetro Industries Corporation**  
 North Washington Street  
 Wilkes-Barre, PA 18705  
 www.metro.com

**Four tier with 63" high posts on casters**

## METROMAX Q™ SHELVING

with \*Microban Antimicrobial Product Protection

Part of the innovative MetroMax iQ™ Storage System, MetroMax Q™ is a longer life storage solution than conventional wire shelving. The product offers durable polymer mats that remove for easy cleaning and protect stored items from damage. Quick adjust shelves and MetroMax iQ accessories provides a very efficient use of storage space. MetroMax Q™ is integrated with online space planning tools and tutorials. [www.metro.com/iQ](http://www.metro.com/iQ)

- Longer-life performance:** Durable, corrosion proof polymer mats protect the shelves from normal wear and tear. Robust epoxy coated steel frames and posts hold as much weight as Metro's wire shelving. Weight capacity for evenly distributed loads:  
 800 lbs. (363kg) per shelf for lengths of 24" to 48" (610 to 1220mm)  
 600 lbs. (275kg) per shelf for lengths of 54" (1370mm) or longer  
 2,000 lbs. (907kg) maximum per stationary unit.
- Interchangeable:** MetroMax Q and MetroMax i™ shelves, posts, and most accessories are compatible on the same unit. Use MetroMax Q shelves with MetroMax i™ polymer posts for increased corrosion protection. Use MetroMax i™ solid shelves when spill containment is required or as a bottom shelf to protect supplies from dirt or backsplashes from mops.
- Easier to clean and maintain:** Polymer mats can be easily removed and cleaned in a sink or dish machine. Microban antimicrobial product protection is built into the high contact areas of the shelf including the mats, frames, and posts to protect the product from bacteria, mold, mildew, and fungus that cause odors and product degradation. Microban protection keeps the product "cleaner between cleanings".
- Quick to Adjust:** Patented corner release allows shelves to be unlocked without tools. Simply flip each corner release, relocate the wedge connectors on the posts, and reposition the shelf. Quickly adjust shelves to reclaim wasted vertical space.
- Smooth, Protective Surfaces:** Smooth shelf mats protect packaged items from unwanted rips, tears, or damage.
- Open Grid and Solid Mat Options:** MetroMax Q is available with open grid mats as standard. Open grid shelves promote air circulation and light penetration.  
 MetroMax i™ solid shelves can be used with MetroMax Q grid shelves on the same unit and are available in 18" and 24" (457 and 610mm) depths. For 21" (530mm) deep MetroMax Q, solid mat overlays are available.
- Efficient, Organized Storage:** Premium MetroMax iQ™ accessories efficiently organize, contain, and compartmentalize **all** space between shelves.
- Quick to Assemble:** MetroMax Q assembles easily in minutes, without tools. Shelves can be adjusted at 1" (25mm) increments along the post. Shelf wedges have a window to locate your desired position.



*MetroMax Q Mobile Unit*



*MetroMax Q with Accessories and MetroMax i Solid Bottom Shelf*

\*MICROBAN® and the MICROBAN® symbol are registered trademarks of the Microban Products Company, Huntersville, NC.



**MetroMax Q™ Polymer and Steel Shelving**

**9.21**



## Specifications

- **Shelf frames and posts:** Steel with electroplated substrate and highly durable, abrasion-resistant epoxy finish. Epoxy finish has built-in Microban antimicrobial product protection. The adjustable foot is reinforced nylon.
- **Shelf Mats:** Injection molded polypropylene with exclusive built-in Microban® antimicrobial product protection.
- **Shelf Wedge Connector:** Reinforced nylon.
- **Temperature range:** -20°F (-29°C) to 125°F (52°C) continuous use, with intermittent exposure to 200°F (93°C) for cleaning.

## Standard Interchangeable Shelves

- Part number includes shelf with removable mats and one bag of wedges.
- MetroMax Q grid shelves, MetroMax i™ grid and solid shelves are all compatible on the same unit.

Nominal Width (in.) (mm)	Nominal Length (in.) (mm)	MetroMax Q Shelf with Grid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)	MetroMax i™ Shelf with Solid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)
18 457	24 610	MQ1824G	6.2 2.8	MX1824F	12.7 5.8
18 457	30 760	MQ1830G	8.0 3.6	MX1830F	14.5 6.6
18 457	36 914	MQ1836G	9.7 4.4	MX1836F	17.2 7.8
18 457	42 1060	MQ1842G	11.4 5.2	MX1842F	20.1 9.1
18 457	48 1220	MQ1848G	13.2 6.0	MX1848F	23.1 10.5
18 457	54 1372	MQ1854G	15.0 6.8	MX1854F	21.5 9.7
18 457	60 1524	MQ1860G	16.7 7.6	MX1860F	23.2 10.5
18 457	72 1829	MQ1872G	20.0 9.1	MX1872F	27.5 12.5
21 530	24 610	MQ2124G	8.0 3.6	—	—
21 530	30 760	MQ2130G	9.7 4.4	—	—
21 530	36 914	MQ2136G	11.4 5.2	—	—
21 530	42 1060	MQ2142G	12.8 5.8	—	—
21 530	48 1220	MQ2148G	14.5 6.6	—	—
21 530	54 1372	MQ2154G	16.7 7.6	—	—
21 530	60 1524	MQ2160G	18.5 8.4	—	—
21 530	72 1829	MQ2172G	21.7 9.9	—	—
24 610	24 610	MQ2424G	9.7 4.4	MX2424F	14.2 6.4
24 610	30 760	MQ2430G	11.4 5.2	MX2430F	15.9 7.2
24 610	36 914	MQ2436G	13.1 6.0	MX2436F	19.6 8.9
24 610	42 1060	MQ2442G	14.1 6.4	MX2442F	21.5 9.8
24 610	48 1220	MQ2448G	15.8 7.1	MX2448F	25.3 11.5
24 610	54 1372	MQ2454G	18.5 8.4	MX2454F	25.0 11.3
24 610	60 1524	MQ2460G	20.3 9.2	MX2460F	26.8 12.1
24 610	72 1829	MQ2472G	23.5 10.7	MX2472F	31.0 14.1

### Actual Dimensions:

Width: Add 3/16" (10mm) to nominal size.  
Length: Subtract 3/16" (5mm) from nominal size.



**MetroMax Q Open Grid Shelf**



**MetroMax i™ Solid Shelf**

## Heavy-Duty Dunnage Shelves

- Corrosion proof MetroMax i™ dunnage shelf is compatible with MetroMax Q.
- Open grid and solid version available.
- Weight capacity per shelf evenly distributed: 1,200 lbs. (544kg) on shelves up to and including 48" (1220mm) long; 900 lbs. (408kg) for shelves 60" (1524mm) long.
- Dunnage shelves are recommended for use on units with four posts.

Nominal Width (in.) (mm)	Nominal Length (in.) (mm)	Shelf with Grid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)	Shelf with Solid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)
18 457	36 914	MHP1836G	18 8.2	MHP1836F	22 10.0
18 457	48 1220	MHP1848G	22 10.0	MHP1848F	26 11.8
18 457	60 1524	MHP1860G	26 11.8	MHP1860F	30 13.6

## Solid Mat Overlays

- Overlays snap onto the open grid mats to create a solid surface.
- Available for 21" (530mm) deep MetroMax Q shelves.

Fits Shelf		Model No.	Approx. Pkd. Wt.	
(in.)	(mm)		(lbs.)	(kg)
21x24	530x610	Q2124SM	0.35	0.16
21x30	530x760	Q2130SM	0.45	0.20
21x36	530x914	Q2136SM	0.50	0.23
21x42	530x1060	Q2142SM	0.60	0.27
21x48	530x1220	Q2148SM	0.70	0.32
21x54	530x1372	Q2154SM	0.80	0.36
21x60	530x1524	Q2160SM	0.90	0.41
21x72	530x1829	Q2172SM	1.00	0.45



**Fuller Middle School**  
Framingham, MA

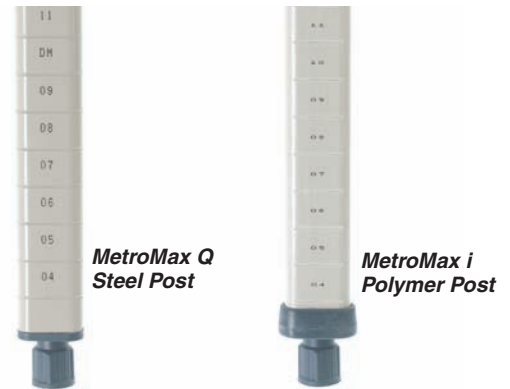
Item #: 11  
Quantity: 9

# METROMAX Q™ POLYMER AND STEEL SHELVING



## Standard Interchangeable Posts

- MetroMax Q: Epoxy coated steel with Microban antimicrobial product protection.
- MetroMax i: Polymer with Microban antimicrobial product protection.
- Stationary posts include an adjustable leveling foot to compensate for uneven floors. Leveling foot can be adjusted 1" (25mm).
- When mounting a shelving unit to a dolly base, stationary posts are used.
- Special height cut posts are available. Consult your Metro representative.



Nominal Height (in.) (mm)	Actual Height* (in.) (mm)	MetroMax Q Steel Model No.	STATIONARY POST WITH LEVELING FOOT				
			Approx. Pkd. Wt. (lbs.) (kg)		MetroMax i Polymer Model No.	Approx. Pkd. Wt. (lbs.) (kg)	
13 370	14 <sup>3</sup> / <sub>4</sub> 375	MQ13PE	1.0	0.5	MX13P	0.5	0.2
27 685	28 <sup>3</sup> / <sub>4</sub> 730	MQ27PE	2.0	0.9	MX27P	0.9	0.4
33 875	34 <sup>3</sup> / <sub>4</sub> 883	MQ33PE	2.5	1.1	MX33P	1.0	0.5
54 1370	54 <sup>3</sup> / <sub>4</sub> 1391	MQ54PE	4.0	1.8	MX54P	1.6	0.7
63 1585	62 <sup>3</sup> / <sub>4</sub> 1594	MQ63PE	4.5	2.0	MX63P	1.8	0.8
74 1690	74 <sup>3</sup> / <sub>4</sub> 1899	MQ74PE	5.5	2.5	MX74P	2.2	1.0
86 2195	86 <sup>3</sup> / <sub>4</sub> 2203	MQ86PE	6.5	2.9	MX86P	2.5	1.1

Nominal Height (in.) (mm)	Actual Height* (in.) (mm)	MetroMax Q Steel Model No.	POST FOR STEM CASTER				
			Approx. Pkd. Wt. (lbs.) (kg)		MetroMax i Polymer Model No.	Approx. Pkd. Wt. (lbs.) (kg)	
13 370	13 <sup>3</sup> / <sub>4</sub> 349	MQ13UPE	1.0	0.5	MX13UP	0.5	0.2
27 685	27 <sup>3</sup> / <sub>4</sub> 705	MQ27UPE	2.0	0.9	MX27UP	0.9	0.4
33 875	33 <sup>3</sup> / <sub>4</sub> 857	MQ33UPE	2.5	1.1	MX33UP	1.0	0.5
54 1370	53 <sup>3</sup> / <sub>4</sub> 1365	MQ54UPE	4.0	1.8	MX54UP	1.6	0.7
63 1585	61 <sup>3</sup> / <sub>4</sub> 1568	MQ63UPE	4.5	2.0	MX63UP	1.8	0.8
70 1778	69 <sup>3</sup> / <sub>4</sub> 1765	MQ70UPE	5.0	2.3			
74 1690	73 <sup>3</sup> / <sub>4</sub> 1873	MQ74UPE	5.5	2.5	MX74UP	2.3	1.0
86 2195	85 <sup>3</sup> / <sub>4</sub> 2178	MQ86UPE	6.5	2.9	MX86UP	2.5	1.4

Replacement Leveling Foot:  
Model No. RPM3-FOOT  
Replacement Post Cap for Steel Post:  
Model No. RPMQS-POSTCAP  
Replacement Post Cap for Polymer Post:  
Model No. RPMXS-POSTCAP  
Replacement MetroMax Q Wedges  
Model No. MQ9985 Bag of 4



Replacement MetroMax Q Wedges MQ9985

### NOTE: Compatibility with existing Metro polymer mat shelving systems

- MQ9985 wedges are compatible with original MetroMax Q shelves and posts.
- The post centers on MetroMax Q have been changed to allow interchangeability with MetroMax i™ shelves. MetroMax Q shelves manufactured within or after April 2009 are not compatible with Q shelves made prior to April 2009.
- MetroMax Q is not compatible with original MetroMax manufactured prior to April 2009.
- Posts listed in above table (ex. MQ74PE, MX74PE) can be used with original MetroMax Q shelves made prior to April 2009.

## Post Clamp

Adds stability by joining posts of two separate units together. With it, each unit is supported by four posts and buttressed by the adjacent unit.

Model No. 9994X



## Foot Plate

Use to add stability to the shelving unit or to bolt units to the floor.

Model No. Zinc 9993Z

Model No. Stainless Steel 9993S



## Stem Casters

A variety of stem casters are offered for MetroMax i™ mobile applications.

Stem caster models include bumpers.



Replacement Bumper M9992DBX





Job: \_\_\_\_\_

Item: \_\_\_\_\_

Quantity: \_\_\_\_\_

## Bun Pan Racks

### Virtually Maintenance Free,

- All welded construction insures the maximum strength and stability of each rack.
- Shipped assembled for immediate use.
- Available in both end and side loading styles, to accommodate 18" x 26", 13" x 18", and 14" x 18" pans

### Easy to Maneuver

- Equipped with four 5" heavy duty platform type casters.
- Non-marking wheels protect floors and minimize noise.
- Caster plates are securely welded to the frame of each unit and casters are then bolted to the caster plate...not directly to the frame...with four bolts. This procedure strengthens the overall integrity of the rack and prevents breakage.

### Guaranteed To Last

- Five-Year Guarantee against material defects and workmanship.
- Lifetime Guarantee against rust and corrosion.

### NSF Certified



#1330



#1461



#1331S



#1461S

This information is for general sales and engineering use

Made For:

Job: \_\_\_\_\_

Item: \_\_\_\_\_

Quantity: \_\_\_\_\_

## Bun Pan Racks

**APPLICATIONS:** General storage and movement of trays and pans.

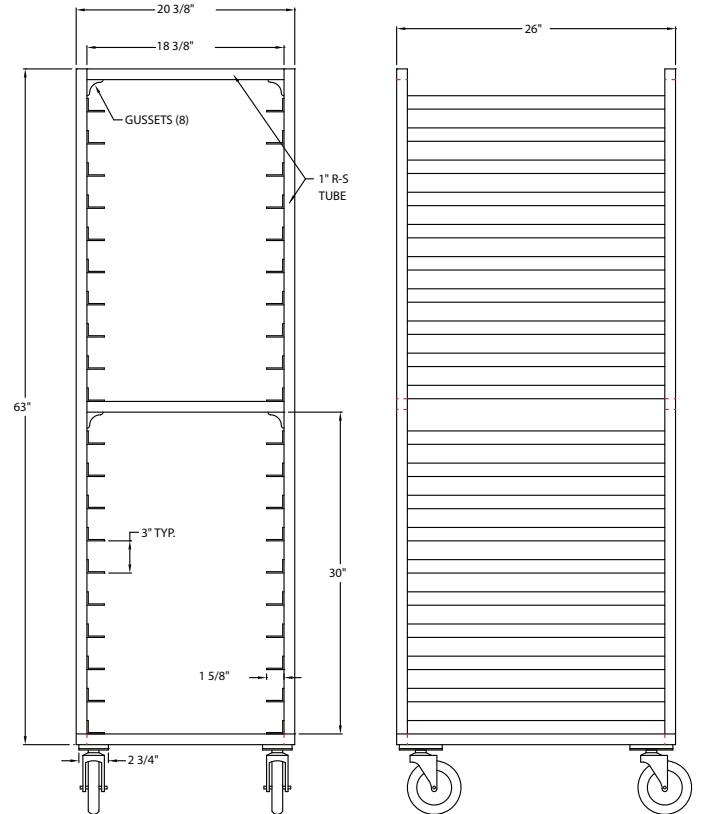
**CONSTRUCTION:** Heavy duty, high tensile, extruded aluminum. Type 6463-T5 alloy.

**TRAY SLIDES:** Slides are 1 1/4" x 1 5/8" x .100 extruded aluminum angle welded to frame.

**FRAME & CROSS SUPPORTS:** Vertical and horizontal frame members are 1" x 1" x .070 extruded aluminum tubing. All welded unit.

**CORNER GUSSETS:** Gussets of 1 1/2" x 1 1/2" x 5/8" thick angle are welded to the inside angles (bottom side) where horizontal cross bracing meets vertical uprights. Note: Each gusset requires 4 1/2" of weld.

**CASTERS:** Platform type, 5" diameter wheel, full swivel design with sealed ball bearing. Wheel material is non-marking polyurethane.



Model No.	Size W-H-D	Pan Cap.	Runner Spacing	Ship Wt.
<b>3/4-SIZE END LOADING RACK</b>				
1361	20 3/8" x 60" x 26"	17	3"	54#
<b>END LOADING RACKS</b>				
1461*	20 11/16" x 69 3/4" x 26"	38	1 1/2"	56#
1330	20 3/8" x 69 3/4" x 26"	30	2"	70#
<b>1331</b>	<b>20 3/8" x 69 3/4" x 26"</b>	<b>20</b>	<b>3"</b>	<b>58#</b>
1332	20 3/8" x 69 3/4" x 26"	15	4"	49#
1333	20 3/8" x 69 3/4" x 26"	12	5"	46#
1334	20 3/8" x 69 3/4" x 26"	10	6"	42#
<b>SIDE LOADING RACKS</b>				
1461S*	28 3/8" x 69 3/4" x 19"	38	1 1/2"	50#
1330S	28 3/8" x 69 3/4" x 19"	30	2"	60#
1331S	28 3/8" x 69 3/4" x 19"	20	3"	51#
1332S	28 3/8" x 69 3/4" x 19"	15	4"	45#
1333S	28 3/8" x 69 3/4" x 19"	12	5"	42#
1334S	28 3/8" x 69 3/4" x 19"	10	6"	41#

**#1331**



Four 5" platform type swivel casters (#C450).

\* #1461 & #1461S Units Hold Pans By The Lip Only.

This information is for general sales and engineering use

Made For:



5 Tier; Sized as shown on plan

Item # \_\_\_\_\_

Job \_\_\_\_\_



SUPER ADJUSTABLE 2™ SUPER ERECTA SHELF®  
Adjustable Wire Shelving

## SUPER ADJUSTABLE 2™ SUPER ERECTA SHELF® WIRE SHELVING

Super Adjustable 2™ Super Erecta Wire Shelving is the most advanced and innovative wire storage system available. The unique Corner Release System, which allows shelves to be adjusted quickly and easily without tools, has been re-engineered to provide increased rigidity. And Super Adjustable 2™ Shelving works in conjunction with the entire Super Erecta System of shelves and accessories.

- **Maximum Space Utilization:** The Corner Release System encourages repositioning of shelves during initial assembly to reclaim wasted vertical space. In some cases, reclaimed vertical space will allow an extra shelving tier to be added to the storage unit resulting in a 25% increase in storage capacity!
- **Easily Assembled:** The unique Corner Release System enables quick and easy repositioning of shelves during the initial set up to accommodate different package or container sizes. "Total Assembly" is complete only after the shelves are properly spaced to maximize storage. SiteSelect™ Posts, with the double-groove visual guide feature, have circular grooves at 1" (25mm) increments and are numbered at 2" (51mm) intervals to easily identify proper shelf locations.
- **Easily Adjustable:** The unique shelf design and SiteSelect™ Posts enable "tool-free", quick adjustment at 1" (25mm) increments along the entire height of the post.
- **Improved Rigidity:** An enhanced Corner Release System has made Super Adjustable 2™ the most rigid, easily adjustable shelving system ever.
- **Strong:** Super Adjustable 2™ shelves hold as much weight as traditional Super Erecta wire shelving. Stationary units hold a maximum of 2,000 lb. (910kg). Maximum weight capacity per shelf (48" [1219mm] or shorter = 800 lb. [364kg]; longer than 48" [1219mm] = 600 lb. [273kg])
- **Choice of Finishes:** Super Adjustable 2™ Super Erecta shelving is available in a variety of finishes: Super Erecta Brite and chrome-plated for dry storage; Metroseal 3™ with antimicrobial product protection and stainless steel for corrosive environments; and attractive black epoxy for merchandising applications.



Dry Storage — Chrome or Super Erecta Brite™



All Environments — Metroseal 3™ with \*Microban® Antimicrobial Product Protection



Mobile Stem Caster Cart



Mobile Dolly Truck

### Super Adjustable 2™ Advantage . . .

Easily reposition Super Adjustable 2™ shelves during initial assembly to increase storage capacity by as much as 25%.



Corner Release System

\*MICROBAN® and the MICROBAN® symbol are registered trademarks of the Microban Products Company, Huntersville, NC.

InterMetro Industries Corporation



Fuller Middle School  
Framingham, MA

Item #: 14  
Quantity: 6

10.01A

# SUPER ADJUSTABLE 2™ SUPER ERECTA SHELF® WIRE SHELVING



## Dimensions

### Super Adjustable 2™ Super Erecta Wire Shelving

Cat. No. Super Erecta Brite	Cat. No. Chrome	Cat. No. Metroseal 3	Cat. No. Stainless	Cat. No. Black	Shelf Width/Length (in.) (mm)	Approx. Pkd. Wt. (lbs.) (kg)
A1424BR	A1424NC	A1424NK3	A1424NS	A1424NBL	14x24 355x610	6 2.7
A1430BR	A1430NC	A1430NK3	A1430NS	A1430NBL	14x30 355x760	7 3.2
A1436BR	A1436NC	A1436NK3	A1436NS	A1436NBL	14x36 355x914	8 3.6
A1442BR	A1442NC	A1442NK3	A1442NS	A1442NBL	14x42 355x1066	9 1/2 4.3
A1448BR	A1448NC	A1448NK3	A1448NS	A1448NBL	14x48 355x1219	10 1/2 4.7
A1460BR	A1460NC	A1460NK3	A1460NS	A1460NBL	14x60 355x1524	14 6.3
A1472BR	A1472NC	A1472NK3	A1472NS	A1472NBL	14x72 355x1825	17 7.7
A1824BR	A1824NC	A1824NK3	A1824NS	A1824NBL	18x24 457x610	7 3.2
A1830BR	A1830NC	A1830NK3	A1830NS	A1830NBL	18x30 457x760	8 3.6
A1836BR	A1836NC	A1836NK3	A1836NS	A1836NBL	18x36 457x914	9 1/2 4.3
A1842BR	A1842NC	A1842NK3	A1842NS	A1842NBL	18x42 457x1066	11 5.0
A1848BR	A1848NC	A1848NK3	A1848NS	A1848NBL	18x48 457x1219	12 5.4
A1854BR	A1854NC	A1854NK3	A1854NS	A1854NBL	18x54 457x1370	14 1/2 6.6
A1860BR	A1860NC	A1860NK3	A1860NS	A1860NBL	18x60 457x1524	17 7.7
A1872BR	A1872NC	A1872NK3	A1872NS	A1872NBL	18x72 457x1825	20 9.1
A2124BR	A2124NC	A2124NK3	A2124NS	A2124NBL	21x24 530x610	8 3.6
A2130BR	A2130NC	A2130NK3	A2130NS	A2130NBL	21x30 530x760	9 4.1
A2136BR	A2136NC	A2136NK3	A2136NS	A2136NBL	21x36 530x914	11 5.0
A2142BR	A2142NC	A2142NK3	A2142NS	A2142NBL	21x42 530x1066	12 5.4
A2148BR	A2148NC	A2148NK3	A2148NS	A2148NBL	21x48 530x1219	14 6.4
A2154BR	A2154NC	A2154NK3	A2154NS	A2154NBL	21x54 530x1370	16 7.3
A2160BR	A2160NC	A2160NK3	A2160NS	A2160NBL	21x60 530x1524	18 8.2
A2172BR	A2172NC	A2172NK3	A2172NS	A2172NBL	21x72 530x1825	24 10.9
A2424BR	A2424NC	A2424NK3	A2424NS	A2424NBL	24x24 610x610	9 4.1
A2430BR	A2430NC	A2430NK3	A2430NS	A2430NBL	24x30 610x760	11 5.0
A2436BR	A2436NC	A2436NK3	A2436NS	A2436NBL	24x36 610x914	13 5.9
A2442BR	A2442NC	A2442NK3	A2442NS	A2442NBL	24x42 610x1066	15 6.8
A2448BR	A2448NC	A2448NK3	A2448NS	A2448NBL	24x48 610x1219	16 7.3
A2454BR	A2454NC	A2454NK3	A2454NS	A2454NBL	24x54 610x1370	18 8.6
A2460BR	A2460NC	A2460NK3	A2460NS	A2460NBL	24x60 610x1524	21 9.5
A2472BR	A2472NC	A2472NK3	A2472NS	A2472NBL	24x72 610x1825	26 11.8
	A3036NC	A3036NK3	A3036NS		30x36 760x914	15 6.8
	A3048NC	A3048NK3	A3048NS		30x48 760x1219	21 9.5
	A3060NC	A3060NK3	A3060NS		30x60 760x1524	26 1/2 11.8
	A3072NC	A3072NK3	A3072NS		30x72 760x1829	31 14.0
	A3636NC	A3636NK3	A3636NS		36x36 910x914	18 8.2
	A3648NC	A3648NK3	A3648NS		36x48 910x1219	23 10.4
	A3660NC	A3660NK3	A3660NS		36x60 910x1524	29 13.1
	A3672NC	A3672NK3	A3672NS		36x72 910x1829	34 1/2 15.4

**NOTE:** MICROBAN® protects the Metroseal 3 coating from bacteria, mold, mildew and fungi that cause odors, stains and product degradation. For Metroseal 3 shelving information see sheet #10.10A.

SUPER ADJUSTABLE 2™ SUPER ERECTA SHELF®  
**Adjustable Wire Shelving**



#### Replacement Parts

Each kit includes components for one original Super Adjustable or Super Adjustable 2 shelf; (4) wedges, (4) sleeves, (4) shelf releases.

**Cat. No. SAKITA2**

#### SiteSelect™ Posts

STATIONARY					MOBILE†					Approx. Pkd. Wt. (lbs.) (kg)
Height* (in.) (mm)	Cat. No. Plated	Cat. No. Metroseal 3	Cat. No. Stainless	Cat. No. Black	Height* (in.) (mm)	Cat. No. Plated	Cat. No. Metroseal 3	Cat. No. Stainless	Cat. No. Black	
7 1/2	191	7P		7PBL						1/2 0.3
14 1/2	370	13P	13PK3	13PS 13PBL						1 0.5
27 1/2	700	27P		27PS 27PBL	27 1/2	699	27UP		27UPS	1 3/4 0.75
34 1/2	875	33P	33PK3	33PS 33PBL	33 7/8	861	33UP	33UPK3	33UPS 33UPBL	2 0.9
54 9/16	1385	54P	54PK3	54PS 54PBL	54	1370	54UP	54UPK3	54UPS 54UPBL	3 1.4
62 9/16	1590	63P	63PK3	63PS 63PBL	62	1575	63UP	63UPK3	63UPS 63UPBL	3 1/2 1.6
					70	1778		70UPK3		3 3/4 1.7
74 5/8	1895	74P	74PK3	74PS 74PBL	74	1880	74UP	74UPK3	74UPS 74UPBL	4 1.8
86 5/8	2200	86P	86PK3	86PS 86PBL	86	2185	86UP	86UPK3	86UPS 86UPBL	4.5 2.0
96 5/8	2454	**96P								1/2 2.5

\*Height includes leveling bolt and cap.

\*\*96P should not be used in units less than 24" (610mm) deep. Consult Metro Engineering for alternate recommendations.

† Post lengths to be specified as cut to a round number, ie: 74P cut to 69"... This will result in an overall post height with adjustment of 69 9/16 to 69 7/8.

‡ Mobile posts come without leveling bolt assembly to accommodate stem casters.

**Important:** When ordering by components remember that for maximum stability, units should be kept as wide and low as possible.

All Metro Catalog Sheets are available on our Web Site: [www.metro.com](http://www.metro.com)



InterMetro Industries Corporation

L02-006A

Printed in U.S.A. Rev. 1/06



**Fuller Middle School**  
Framingham, MA

Item #: 14  
Quantity: 6



**LIFETIME TOUGH**

**CORRECTIONS APPROVED**



**EXD2048**



**328ES**

Item No. \_\_\_\_\_

Quantity \_\_\_\_\_

Job Name \_\_\_\_\_

Spec No. \_\_\_\_\_

## DUNNAGE RACKS

**LIFETIME TOUGH**

ALUMINUM OR STAINLESS CONSTRUCTION

Custom Sizes Available

### TUBULAR DUNNAGE RACKS

Aluminum Construction

Model	H	W	D	Weight
EXD2036	12"	36"	20"	14
EXD2042	12"	42"	20"	15
EXD2048	12"	48"	20"	16
EXD2054	12"	54"	20"	17
EXD2060	12"	60"	20"	18
EXD2436	12"	36"	24"	15
EXD2442	12"	42"	24"	16
EXD2448	12"	48"	24"	17
EXD2454	12"	54"	24"	18
EXD2460	12"	60"	24"	19

### CHANNEL ARCH DUNNAGE RACKS

Stainless Construction

Model	H	W	D	Weight
328ES	12"	36"	20"	16
329ES	12"	42"	20"	28
330ES	12"	48"	20"	20
331ES	12"	54"	20"	22
332ES	12"	60"	20"	24

Add /8 after model number for 8" height.

See **Mobile Dunnage Dollies** spec sheet for caster options.

**APPLICATIONS:** Lifetime dunnage racks keep product organized and off of the floor. Meets all sanitary health codes. Made to measure for walk-in freezers, refrigerators and dry storage areas.

**CONSTRUCTION:** Heavy duty, high tensile extruded aluminum. Type 6063-T5 alloy. Lifetime guarantee against rust. Shipped fully assembled and ready for use.

**EXD - Series:** Heavy Duty construction with high tensile aluminum 4" E channel.

**ES - Series:** All heli-arc welded, 1" Sq. tubular stainless construction. 4000 lbs. distributed weight capacity.



Notes

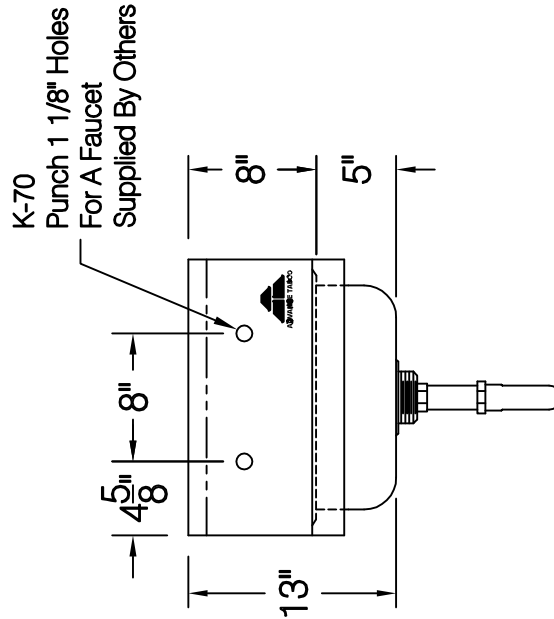
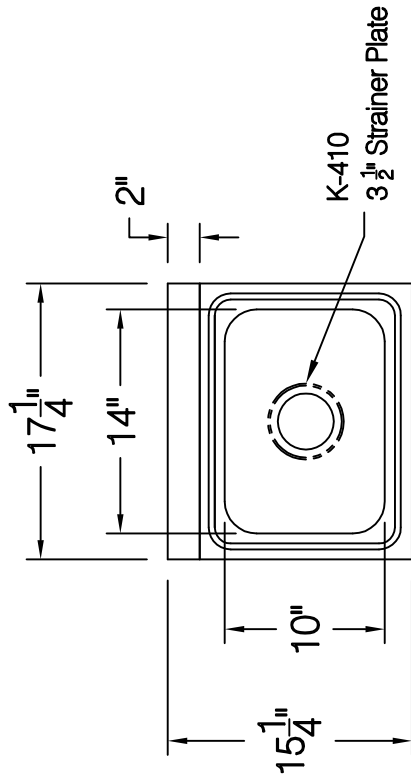
55 Channel Drive • Port Washington, NY 11050-2216

8891 NW 102nd Street • Medlev, FL 33178



Fuller Middle School  
Framingham, MA

Item #: 15  
Quantity: 2



 SE TABCO FLAND BLVD NY 11717-8380 1-845-3166 -242-4589	JOB NAME:	Order / Drawing#	DATE:	NO.	REVISIONS:	BY	Print Approval
	MODEL #:	Qty:	Item #:	1	2	3	Accessory Locations MUST Be Verified Prior To Unit Being Fabricated
CUSTOMER:	PO#	Tolerance:	02/04/13	4	5	6	Locations Verified By
Crabtree McGrath Assoc.	7-CM-66	MATERIAL:	20 ga. 304 S/S	7	8	Print Approved By	Date
	DRAWN BY:	Scale:	1 = 12	FINAL INSPECTION: 1) DATE: _____ INSPECTED BY: _____ 2) DATE: _____ INSPECTED BY: _____			
	T. Anderson	NSI					



**T&S BRASS AND BRONZE WORKS, INC.**  
 2 SADDLEBACK COVE / P.O. BOX 1088 / TRAVELERS REST, SC 29690  
 PHONE 800-476-4103 FAX 864- 834-3518



Model No.

~~B-0330-04~~

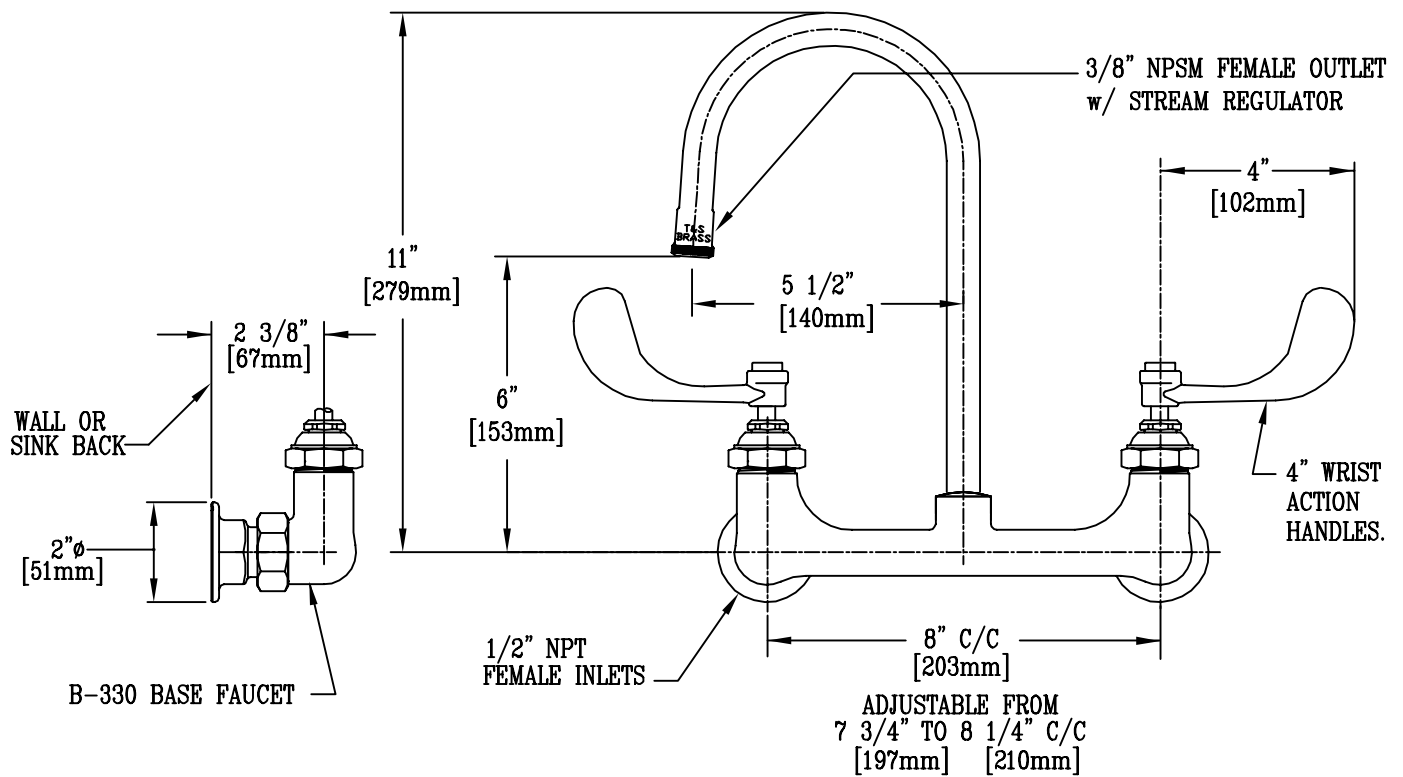
Item No.:

Job Name:

Architect/Engineer Approval:

Notes:

Provide a 119X gooseneck with  
 B-2199-02F-10 aerator tip in lieu of standard



NSF STANDARD 61, SECTION 9 CERTIFIED.

Product Description:

8" c/c WALL MOUNTED MIXING FAUCET w/

Drawn:

WJS

Checked:

MVW

Scale:

1:4



**Fuller Middle School**  
 Framingham, MA

Item #: 16  
 Quantity: 3



**T&S BRASS AND BRONZE WORKS, INC.**  
 2 Saddleback Cove / P.O. Box 1088  
 Travelers Rest, SC 29690

Model No.  
**B-0199-02-F10**

Item No.

Travelers Rest, SC: 800-476-4103 • Simi Valley, CA: 800-423-0150 • Fax: 864-834-3518 • www.tsbrass.com

This Space for Architect/Engineer Approval

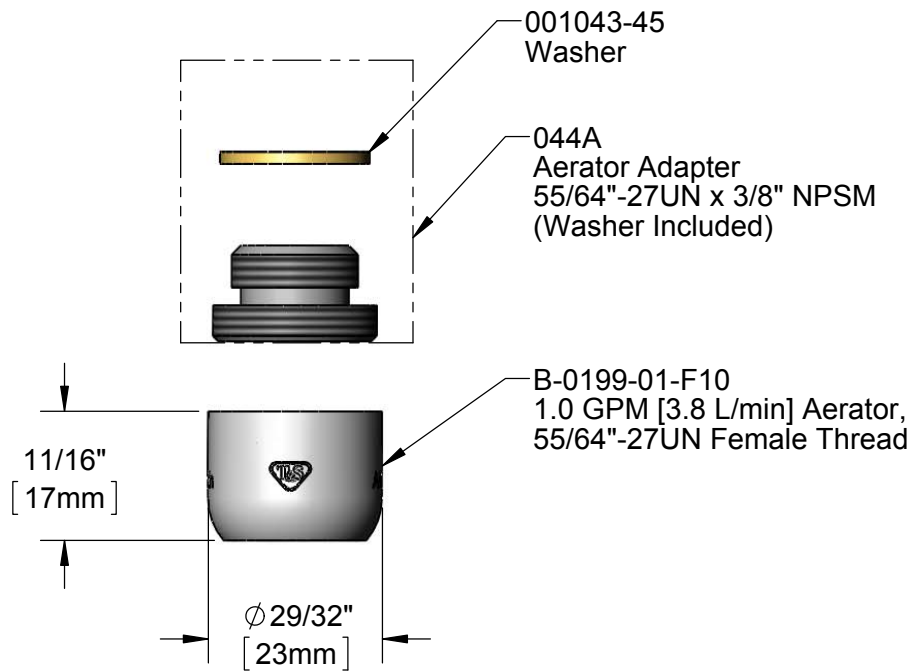
Job Name \_\_\_\_\_ Date \_\_\_\_\_

Model Specified \_\_\_\_\_ Quantity \_\_\_\_\_

Customer/Wholesaler \_\_\_\_\_

Contractor \_\_\_\_\_

Architect/Engineer \_\_\_\_\_



Product Specifications:  
 1.0 GPM Aerator w/ 3/8" NPSM Male Adapter

Drawn  
**KJG**

Checked  
**DHL**

Approved  
**JHB**



**Fuller Middle School**  
 Framingham, MA

Item #: 16  
 Quantity: 3





# SlimJim

The Slim Jim® container delivers the durability needed for commercial environments combined with brand new innovation to increase worker productivity. New product features and accessories deliver the most efficient solution for collection, transportation, and disposal of multi-stream waste and recyclables.

## Features and Benefits:

- Venting channels make removing liners up to 80% easier, improving productivity and reducing the risk of worker injury
- Four bag cinches secure liners around the rim of the container and allow for quick, knot-free liner changes
- Handles at the base and rim of the container improve grip and control while lifting and emptying full containers
- Rim with rib-strengthened design increases strength and resists crushing
- Build a recycling station with a variety of dolly and lid options to meet any facility need

## COLORS AVAILABLE

Blue, Green, Black, Beige, Brown, Gray, Yellow\*, Red\*

\* 23-gallon only

## Material Composition:

Injection molded with a high-quality resin blend.

## Accessories:

### STAINLESS STEEL DOLLIES

- Slim Jim® Single Dolly
- Slim Jim® Double Dolly
- Slim Jim® Triple Dolly
- Slim Jim® Quadruple Dolly

### RESIN DOLLY

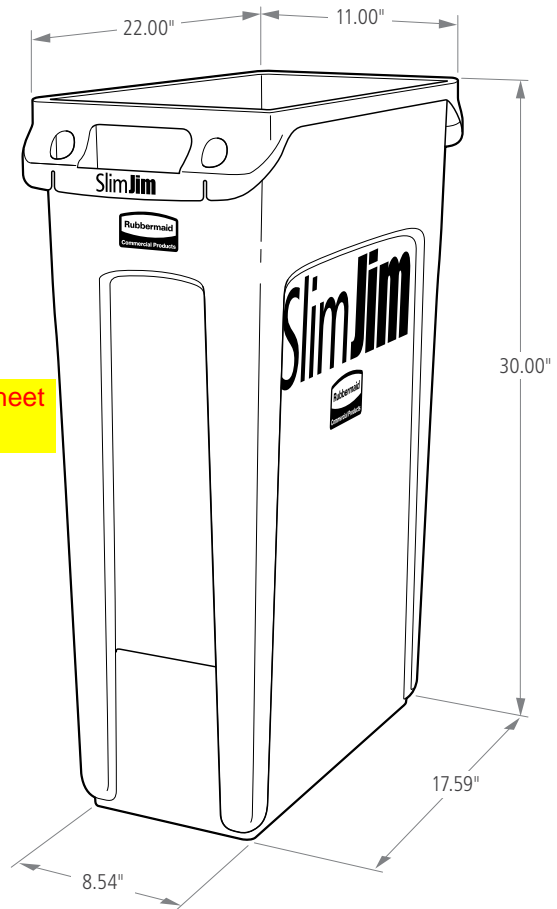
- Slim Jim® Trainable Dolly

### LIDS

- Bottles and Cans Lid
- Paper Lid
- Mixed Recycling Lid
- Hinged Lid
- Swing Lid

# SLIM JIM® CONTAINERS

Provided by Owner; Cutsheet provided for design intent



23-Gallon Slim Jim® Container



Fuller Middle School  
Framingham, MA

Item #: 17  
Quantity: 3

# SLIM JIM® CONTAINERS

SKU #	DESCRIPTION	COLOR	CAPACITY		LENGTH		WIDTH		HEIGHT		PACK SIZE
			GAL	L	IN	CM	IN	CM	IN	CM	
1971258	SLIM JIM® CONTAINER	GRAY	16	61	22"	55.88	11"	27.94	25"	63.50	4
1955959	SLIM JIM® CONTAINER	BLACK	16	61	22"	55.88	11"	27.94	25"	63.50	4
1971259	SLIM JIM® CONTAINER	BEIGE	16	61	22"	55.88	11"	27.94	25"	63.50	4
1956181	SLIM JIM® CONTAINER	BROWN	16	61	22"	55.88	11"	27.94	25"	63.50	4
1971257	SLIM JIM® CONTAINER	BLUE	16	61	22"	55.88	11"	27.94	25"	63.50	4
1955960	SLIM JIM® CONTAINER	GREEN	16	61	22"	55.88	11"	27.94	25"	63.50	4
FG354060GRAY	SLIM JIM® CONTAINER	GRAY	23	87	22"	55.88	11"	27.94	30"	76.20	4
FG354060BLA	SLIM JIM® CONTAINER	BLACK	23	87	22"	55.88	11"	27.94	30"	76.20	4
FG354060BEIG	SLIM JIM® CONTAINER	BEIGE	23	87	22"	55.88	11"	27.94	30"	76.20	4
1956187	SLIM JIM® CONTAINER	BROWN	23	87	22"	55.88	11"	27.94	30"	76.20	4
1956185	SLIM JIM® CONTAINER	BLUE	23	87	22"	55.88	11"	27.94	30"	76.20	4
1956186	SLIM JIM® CONTAINER	GREEN	23	87	22"	55.88	11"	27.94	30"	76.20	4
1956188	SLIM JIM® CONTAINER	YELLOW	23	87	22"	55.88	11"	27.94	30"	76.20	4
1956189	SLIM JIM® CONTAINER	RED	23	87	22"	55.88	11"	27.94	30"	76.20	4
FG354007BLUE	SLIM JIM® CONTAINER	BLUE (RECYCLING)	23	87	22"	55.88	11"	27.94	30"	76.20	4
FG354007GRN	SLIM JIM® CONTAINER	GREEN (RECYCLING)	23	87	22"	55.88	11"	27.94	30"	76.20	4



# SlimJim

A variety of lid options for Slim Jim® containers encourages waste separation and recycling with interchangeable, color-coded tops.

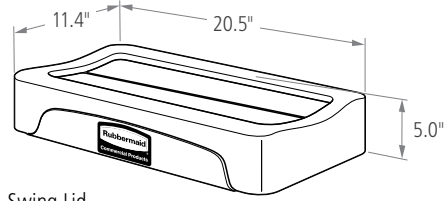
## Features and Benefits:

### SLIM JIM® LIDS

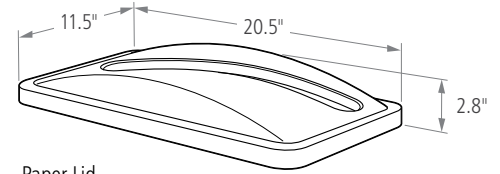
- **Swing Lid** conceals waste from view and provides no-touch access
- **Hinged Lid** folds flat while in use and completely covers waste when closed; complies with Health and Human Services Standard 5-501.11.3 of the 2005 FDA Food Code
- **Bottles and Cans Lid/Paper Lid/Mixed Recycling Lid** encourages waste separation and recycling with interchangeable color-coded tops

## Material Composition:

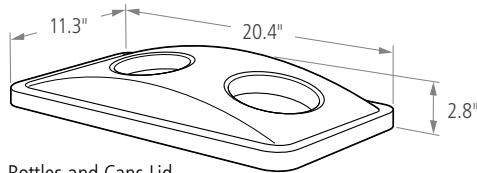
Injection-grade resin material



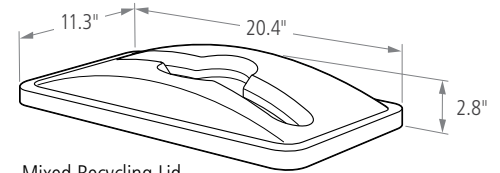
Swing Lid



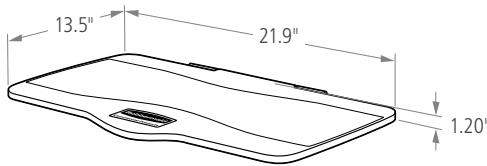
Paper Lid



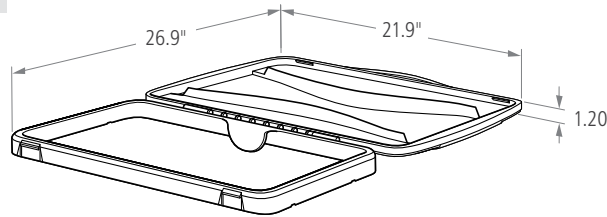
Bottles and Cans Lid



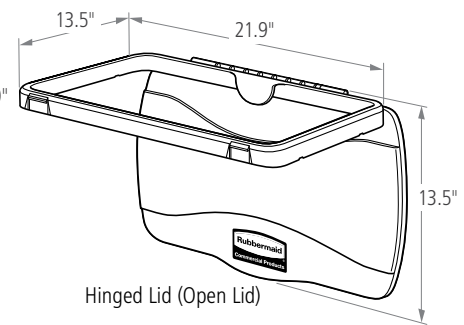
Mixed Recycling Lid



Hinged Lid (Closed Lid)



Hinged Lid (Open Lid)



Hinged Lid (Open Lid)

SKU #	DESCRIPTION	COLOR	LENGTH		WIDTH		HEIGHT		PACK SIZE
			IN	CM	IN	CM	IN	CM	
FG267360BEIG	SWING LID	BEIGE	20.50"	52.07	11.40"	28.95	5"	12.70	4
FG267360BLA	SWING LID	BLACK	20.50"	52.07	11.40"	28.95	5"	12.70	4
FG267360BLU	SWING LID	BLUE	20.50"	52.07	11.40"	28.95	5"	12.70	4
FG267360GRY	SWING LID	GRAY	20.50"	52.07	11.40"	28.95	5"	12.70	4
1829400	SWING LID	GREEN	20.50"	52.07	11.40"	28.95	5"	12.70	4
FG269288BLU	BOTTLES AND CANS LID	BLUE	20.40"	51.82	11.30"	28.70	2.80"	7.11	4
FG269288BRN	BOTTLES AND CANS LID	BROWN	20.40"	51.82	11.30"	28.70	2.80"	7.11	4
FG269288GRN	BOTTLES AND CANS LID	GREEN	20.40"	51.82	11.30"	28.70	2.80"	7.11	4
FG269288RED	BOTTLES AND CANS LID	RED	20.40"	51.82	11.30"	28.70	2.80"	7.11	4
FG269288YEL	BOTTLES AND CANS LID	YELLOW	20.40"	51.82	11.30"	28.70	2.80"	7.11	4
FG270388BLU	PAPER LID	BLUE	20.50"	52.07	11.50"	29.21	2.80"	7.11	4
FG270388GRN	PAPER LID	GREEN	20.50"	52.07	11.50"	29.21	2.80"	7.11	4
1788372	MIXED RECYCLING LID	BLUE	20.40"	51.82	11.30"	28.70	2.80"	7.11	4
FG267400BLA	HINGED LID	BLACK	21.90"	55.63	13.50"	34.29	1.20"	3.05	4



Fuller Middle School  
Framingham, MA

Item #: 17  
Quantity: 3



**SlimJim**

# DOLLIES FOR SLIM JIM® CONTAINERS

A variety of dolly options for Slim Jim® containers allow for more efficient collection and transport of waste and recyclables, increasing worker productivity.

## Features and Benefits:

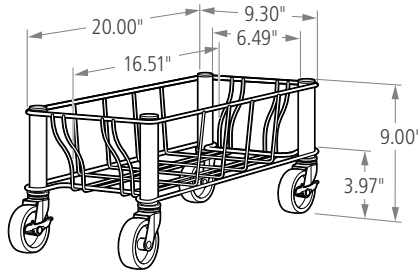
### STAINLESS STEEL DOLLIES

- Collect and transport up to four streams of waste and recyclables with the new stainless steel multi-dollies for Slim Jim® containers
- Constructed of quality stainless steel material that is easy to clean and won't rust or chip in commercial environments
- Features 3" nonmarking quiet casters that allow for smooth and quiet maneuverability
- Locking feature on casters creates a stable recycling station or collection site
- Fits both 16- and 23-gallon Slim Jim® containers

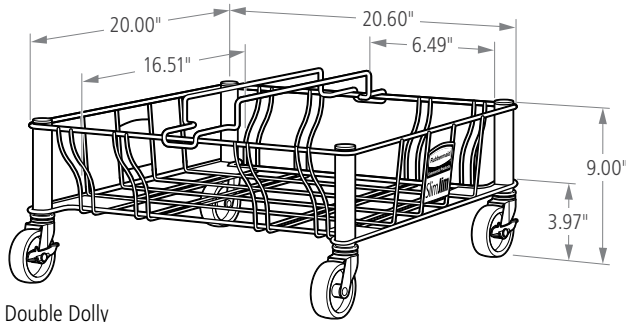
## Material Composition:

### STAINLESS STEEL DOLLIES

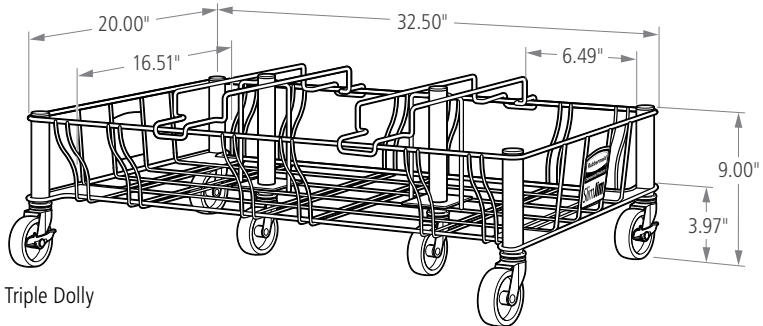
- High-quality stainless steel



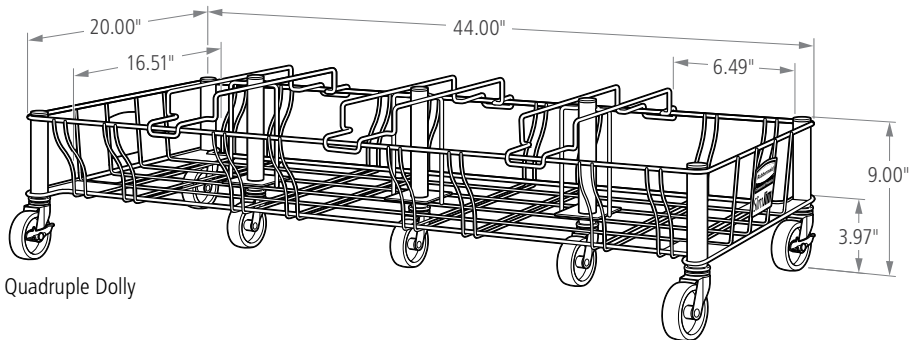
Single Dolly



Double Dolly



Triple Dolly



Quadruple Dolly

## DOLLY SPECIFICATIONS

SKU #	DESCRIPTION	CAPACITY		LENGTH		WIDTH		HEIGHT		PACK SIZE	HEIGHT OFF GROUND			
		LBS	KG	IN	CM	IN	CM	IN	CM		IN	CM	IN	CM
1068468	STAINLESS STEEL SINGLE DOLLY	100	45	20"	50.80	9.30"	23.67	9"	22.86	2	28.80"	72.30	23.00"	86.20



Fuller Middle School  
Framingham, MA

Item #: 17  
Quantity: 3

**ITEM 18**

**CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION:**      **Prep Table with Sink**

**NO CUT SHEET AVAILABLE**

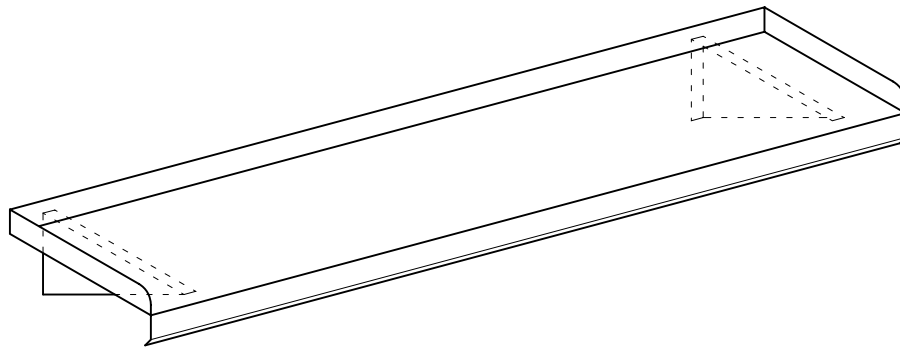
**CONSTRUCTION FEATURES:**

Make - Fabricate per General Construction this Section

Size - 12'-0" x 30" x 36" high to work surface plus 10" high splash at rear; two 18" x 18" x 10" deep integral sink basins

Construction - 14 gauge stainless steel top, basins and splash, angle reinforced, eight legs with gussets and adjustable feet, partial undershelf, rear splash, and turn down front and ends, secured 3" off face of wall.

Accessories - Drawer assembly, splash mounted faucet set and two 2" lever waste outlets.



## **CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION:**      **Wall shelf**

12'-0" x 10" mounted 54" above finished floor

**NO CUT SHEET AVAILABLE**

### **CONSTRUCTION FEATURES:**

16 gauge stainless steel shelf

Rear and ends turned up 1-1/2" and corners welded

Front turned down 1-1/2" and in 1/2" at 45°

Mount on three 14 gauge stainless steel flag brackets with suitable anchors

R 301 Ultra B



<b>D</b>	Number of meals per service	10 to 30
	Quantity per batch in cutter function	Up to 3.3 lbs

**A SALES FEATURES**

The R 301 Ultra B Bowl Cutter Mixer is ideal for grinding, mincing and kneading, as well as for making mousses, emulsions and smooth stuffings. It effortlessly performs even the lengthiest task in just a few minutes, consistently producing a flawless end product.

**B TECHNICAL FEATURES**

R 301 Ultra B Bowl Cutter Mixer. Single phase 120/60/1. Power 1.5 HP. Speed: 1725 rpm. 3.5 qt. cutter bowl in stainless steel and smooth bowl-base blade assembly. 10 to 30 meals. Select your options at the back page, **F** part.

**C TECHNICAL DATA**

<b>Output power</b>	1.5 HP
<b>Electrical data</b>	120V/60/1 - 12 Amp
<b>Speed</b>	1725 rpm
<b>Dimensions (WxDxH)</b>	8 1/2"x11 15/16"x15 11/16"
<b>Rate of recyclability</b>	95%
<b>Net weight</b>	23 lbs
<b>Nema #</b>	5-15P
<b>Reference</b>	R 301 U B120V/60/1

**E PRODUCT FEATURES / BENEFITS**

**MOTOR BASE**

- Direct drive induction motor (no belt) for intensive use.
- Power 1.5 HP
- Stainless steel motor shaft.
- Motor base made from heavy-duty composite material.
- Magnetic safety system, thermal failsafe and motor brake.
- **Speed:** 1725 rpm.
- **Pulse** button for better cut precision.

**CUTTER FUNCTION**

- 3.5 qt. stainless-steel cutter bowl with handle for better grip
- Bowl-base high resistance smooth blade assembly for homogeneous processing even for small amounts
- Central lid opening for adding liquid or solid ingredients during processing
- High heat- and shock-resistant see-through lid to monitor processing from start to finish
- All parts are dishwasher-safe and can easily be removed for cleaning

**ACCESSORIES INCLUDED**

- Cutter attachment: lid, bowl, and high resistance stainless steel smooth blade assembly with removable cap.

**STANDARDS**

ETL electrical and sanitation Listed/ cETL (Canada)



R 301 Ultra B

**F** OPTIONAL ACCESSORIES

- Coarse serrated blade assembly for kneading and grinding, ref 27288
- Fine serrated blade assembly for chopping herbs and spices, ref 27287
- Cuisine Kit ref 27396



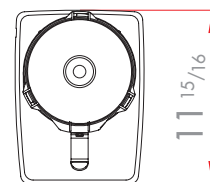
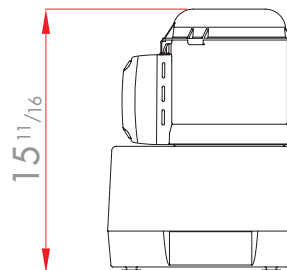
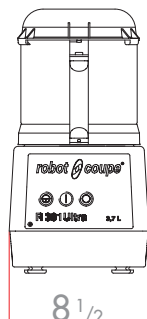
Coarse-serrated



Fine-serrated

**G** ELECTRICAL DATA

120V/60/1 - delivered with cord and plug



R 301 Ultra B



# Etlund S-11 NSF Manual Can Openers

For the very highest standard in food safety and sanitation, the S-11 manual can opener has over 17 years of success in foodservice worldwide utilizing proprietary can opening technology. The patented S-11 has successfully opened nearly one billion cans without a single complaint – giving it a stainless reputation. Add in the industry’s longest warranty and you’ve got an opener that’s a cut above any other.



# Open up to a higher standard in food safety.



### Dishwasher Safe

Toss in the dishwasher for easy cleaning. The industry's first all-stainless can opener, the S-11 resists rust and stays looking new, no matter how many times it's washed.



### Fewer Parts

The S-11's advanced design means fewer parts than most other openers, and its patented Quick Change Mechanism makes knife and gear replacement fast and easy.

### Quick Change Mechanism

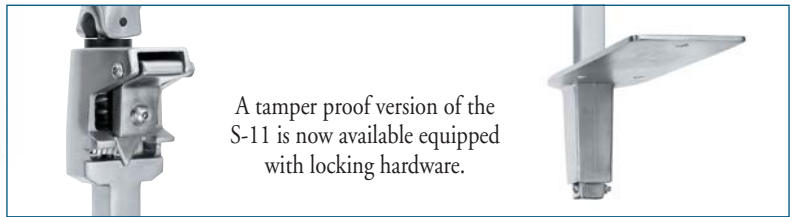
Makes gear replacement fast and easy.



S-11 with clamp base

Tamper proof S-11 opener with tamper proof base

ST-93 Rustproof can opener cleaning tool



A tamper proof version of the S-11 is now available equipped with locking hardware.

### SPECIFICATIONS:

MODEL #	DESCRIPTION	PRODUCT CODE	CASE CUBE FT <sup>3</sup> /M <sup>3</sup>	CASE WEIGHT LBS./KGS
S-11	Quick change can opener with standard length bar and new plated base	15000	3.3/0.1	30/13.6
S-11 L	Opener with stainless steel base	15300	3.3/0.1	30/13.6
S-11 E	Opener with stainless steel clamp base	15400	3.3/0.1	31/14.1
S-11 C	Opener with long bar and plated steel base	15020	3.3/0.1	30/13.6
S-11 CL	Opener with long bar and stainless steel base	15320	3.3/0.1	30/13.6
S-11 CE	Opener with long bar and cast stainless steel clamp base	15420	3.3/0.1	32/14.5
S-11 WB	Opener with long bar and cast stainless steel clamp base	15200	3.3/0.1	21/9.5
S-11 TP	Tamper proof opener with tamper proof base	15080	3.3/0.1	30/13.6
ST-93	Rustproof can opener cleaning tool	38500		.5/.2

Note: S-11 Series standard length bar is 16" (40.6 cm) long. Extra long bar is 22" (55.9 cm) long.



Fuller Middle School  
Framingham, MA

Item #: 21  
Quantity: 1

Provided by Owner; Cutsheet provided for design intent



# Round Brute® Containers



Dolly 2640



Lid 2650



Lid 3543



Lid 2637-88  
Lid 2657-88



Caddy Bag 2642

## Industry leader in waste and material handling applications.

- All-plastic, professional-grade construction will not rust, chip or peel; resists dents.
- Strong, snap-on lids are available for secure, stable stacking.
- Reinforced rims add strength and durability.
- Built-in handles allow easy, non-slip lifting and anti-jam nesting.
- Double-ribbed base increases stability and dragging capacity.
- Gray, White and Yellow are USDA Meat & Poultry Equipment Group Listed and assist in complying with HACCP guidelines.
- Easy twist on, twist off dolly provides safe mobility.
- Certified to NSF Std. #2 (gray, white and yellow) and Std. #21.
- 2632/2637, 2643/2647 are CSFM approved when used as container/lid combo.
- 2640 casters are non-marking.

<b>Brute</b>	2655	2643	2632	2620	2610
<b>Lid</b>	2654	2645	2631	2619	2609
<b>Funnel Lid</b>			2632		
<b>Dome Lid</b>	2657-88		2637-88		
<b>Dolly</b>	2640	2640	2640	2640	
<b>Dolly</b>	2650				
<b>Caddy Bag</b>		2642	2642		
<b>Dimensions</b>	26½ dia x 33" h	24" dia x 31½" h	22" dia x 27¼" h	19½" dia x 22" h	15½" dia x 17½" h
<b>Capacity</b>	55 gal	44 gal	32 gal	20 gal	10 gal
<b>Colors</b>	G	DB, G, R, W, Y	DB, G, R, W, Y	DB, G, W, Y	G, W



Fuller Middle School  
Framingham, MA

Item #: 22  
Quantity: 5



**InterMetro Industries Corporation**  
 North Washington Street  
 Wilkes-Barre, PA 18705  
 www.metro.com

**Four tier with 63" high posts on casters**

## METROMAX Q™ SHELVING

with \*Microban Antimicrobial Product Protection

Part of the innovative MetroMax iQ™ Storage System, MetroMax Q™ is a longer life storage solution than conventional wire shelving. The product offers durable polymer mats that remove for easy cleaning and protect stored items from damage. Quick adjust shelves and MetroMax iQ accessories provides a very efficient use of storage space. MetroMax Q™ is integrated with online space planning tools and tutorials. [www.metro.com/iQ](http://www.metro.com/iQ)

- Longer-life performance:** Durable, corrosion proof polymer mats protect the shelves from normal wear and tear. Robust epoxy coated steel frames and posts hold as much weight as Metro's wire shelving. Weight capacity for evenly distributed loads:  
 800 lbs. (363kg) per shelf for lengths of 24" to 48" (610 to 1220mm)  
 600 lbs. (275kg) per shelf for lengths of 54" (1370mm) or longer  
 2,000 lbs. (907kg) maximum per stationary unit.
- Interchangeable:** MetroMax Q and MetroMax i™ shelves, posts, and most accessories are compatible on the same unit. Use MetroMax Q shelves with MetroMax i™ polymer posts for increased corrosion protection. Use MetroMax i™ solid shelves when spill containment is required or as a bottom shelf to protect supplies from dirt or backsplashes from mops.
- Easier to clean and maintain:** Polymer mats can be easily removed and cleaned in a sink or dish machine. Microban antimicrobial product protection is built into the high contact areas of the shelf including the mats, frames, and posts to protect the product from bacteria, mold, mildew, and fungus that cause odors and product degradation. Microban protection keeps the product "cleaner between cleanings".
- Quick to Adjust:** Patented corner release allows shelves to be unlocked without tools. Simply flip each corner release, relocate the wedge connectors on the posts, and reposition the shelf. Quickly adjust shelves to reclaim wasted vertical space.
- Smooth, Protective Surfaces:** Smooth shelf mats protect packaged items from unwanted rips, tears, or damage.
- Open Grid and Solid Mat Options:** MetroMax Q is available with open grid mats as standard. Open grid shelves promote air circulation and light penetration.  
 MetroMax i™ solid shelves can be used with MetroMax Q grid shelves on the same unit and are available in 18" and 24" (457 and 610mm) depths. For 21" (530mm) deep MetroMax Q, solid mat overlays are available.
- Efficient, Organized Storage:** Premium MetroMax iQ™ accessories efficiently organize, contain, and compartmentalize **all** space between shelves.
- Quick to Assemble:** MetroMax Q assembles easily in minutes, without tools. Shelves can be adjusted at 1" (25mm) increments along the post. Shelf wedges have a window to locate your desired position.



**MetroMax Q Mobile Unit**



**MetroMax Q with Accessories and MetroMax i Solid Bottom Shelf**

\*MICROBAN® and the MICROBAN® symbol are registered trademarks of the Microban Products Company, Huntersville, NC.



**MetroMax Q™ Polymer and Steel Shelving**

**9.21**



**Fuller Middle School**  
**Framingham, MA**

**Item #: 23**  
**Quantity: 2**



## Specifications

- **Shelf frames and posts:** Steel with electroplated substrate and highly durable, abrasion-resistant epoxy finish. Epoxy finish has built-in Microban antimicrobial product protection. The adjustable foot is reinforced nylon.
- **Shelf Mats:** Injection molded polypropylene with exclusive built-in Microban® antimicrobial product protection.
- **Shelf Wedge Connector:** Reinforced nylon.
- **Temperature range:** -20°F (-29°C) to 125°F (52°C) continuous use, with intermittent exposure to 200°F (93°C) for cleaning.

## Standard Interchangeable Shelves

- Part number includes shelf with removable mats and one bag of wedges.
- MetroMax Q grid shelves, MetroMax i™ grid and solid shelves are all compatible on the same unit.

Nominal Width (in.) (mm)	Nominal Length (in.) (mm)	MetroMax Q Shelf with Grid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)	MetroMax i™ Shelf with Solid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)
18 457	24 610	MQ1824G	6.2 2.8	MX1824F	12.7 5.8
18 457	30 760	MQ1830G	8.0 3.6	MX1830F	14.5 6.6
18 457	36 914	MQ1836G	9.7 4.4	MX1836F	17.2 7.8
18 457	42 1060	MQ1842G	11.4 5.2	MX1842F	20.1 9.1
18 457	48 1220	MQ1848G	13.2 6.0	MX1848F	23.1 10.5
18 457	54 1372	MQ1854G	15.0 6.8	MX1854F	21.5 9.7
18 457	60 1524	MQ1860G	16.7 7.6	MX1860F	23.2 10.5
18 457	72 1829	MQ1872G	20.0 9.1	MX1872F	27.5 12.5
21 530	24 610	MQ2124G	8.0 3.6	—	—
21 530	30 760	MQ2130G	9.7 4.4	—	—
21 530	36 914	MQ2136G	11.4 5.2	—	—
21 530	42 1060	MQ2142G	12.8 5.8	—	—
21 530	48 1220	MQ2148G	14.5 6.6	—	—
21 530	54 1372	MQ2154G	16.7 7.6	—	—
21 530	60 1524	MQ2160G	18.5 8.4	—	—
21 530	72 1829	MQ2172G	21.7 9.9	—	—
24 610	24 610	MQ2424G	9.7 4.4	MX2424F	14.2 6.4
24 610	30 760	MQ2430G	11.4 5.2	MX2430F	15.9 7.2
24 610	36 914	MQ2436G	13.1 6.0	MX2436F	19.6 8.9
24 610	42 1060	MQ2442G	14.1 6.4	MX2442F	21.5 9.8
24 610	48 1220	MQ2448G	15.8 7.1	MX2448F	25.3 11.5
24 610	54 1372	MQ2454G	18.5 8.4	MX2454F	25.0 11.3
24 610	60 1524	MQ2460G	20.3 9.2	MX2460F	26.8 12.1
24 610	72 1829	MQ2472G	23.5 10.7	MX2472F	31.0 14.1

### Actual Dimensions:

Width: Add 3/16" (10mm) to nominal size.  
Length: Subtract 3/16" (5mm) from nominal size.



**MetroMax Q Open Grid Shelf**



**MetroMax i™ Solid Shelf**

## Heavy-Duty Dunnage Shelves

- Corrosion proof MetroMax i™ dunnage shelf is compatible with MetroMax Q.
- Open grid and solid version available.
- Weight capacity per shelf evenly distributed: 1,200 lbs. (544kg) on shelves up to and including 48" (1220mm) long; 900 lbs. (408kg) for shelves 60" (1524mm) long.
- Dunnage shelves are recommended for use on units with four posts.

Nominal Width (in.) (mm)	Nominal Length (in.) (mm)	Shelf with Grid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)	Shelf with Solid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)
18 457	36 914	MHP1836G	18 8.2	MHP1836F	22 10.0
18 457	48 1220	MHP1848G	22 10.0	MHP1848F	26 11.8
18 457	60 1524	MHP1860G	26 11.8	MHP1860F	30 13.6

## Solid Mat Overlays

- Overlays snap onto the open grid mats to create a solid surface.
- Available for 21" (530mm) deep MetroMax Q shelves.

Fits Shelf		Model No.	Approx. Pkd. Wt.	
(in.)	(mm)		(lbs.)	(kg)
21x24	530x610	Q2124SM	0.35	0.16
21x30	530x760	Q2130SM	0.45	0.20
21x36	530x914	Q2136SM	0.50	0.23
21x42	530x1060	Q2142SM	0.60	0.27
21x48	530x1220	Q2148SM	0.70	0.32
21x54	530x1372	Q2154SM	0.80	0.36
21x60	530x1524	Q2160SM	0.90	0.41
21x72	530x1829	Q2172SM	1.00	0.45



**Fuller Middle School**  
Framingham, MA

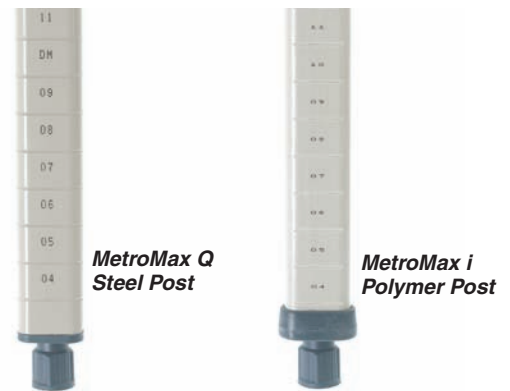
Item #: 23  
Quantity: 2

# METROMAX Q™ POLYMER AND STEEL SHELVING



## Standard Interchangeable Posts

- MetroMax Q: Epoxy coated steel with Microban antimicrobial product protection.
- MetroMax i: Polymer with Microban antimicrobial product protection.
- Stationary posts include an adjustable leveling foot to compensate for uneven floors. Leveling foot can be adjusted 1" (25mm).
- When mounting a shelving unit to a dolly base, stationary posts are used.
- Special height cut posts are available. Consult your Metro representative.



Nominal Height (in.) (mm)	Actual Height* (in.) (mm)	MetroMax Q Steel Model No.	STATIONARY POST WITH LEVELING FOOT				
			Approx. Pkd. Wt. (lbs.) (kg)		MetroMax i Polymer Model No.	Approx. Pkd. Wt. (lbs.) (kg)	
13 370	14 <sup>3</sup> / <sub>4</sub> 375	MQ13PE	1.0	0.5	MX13P	0.5	0.2
27 685	28 <sup>3</sup> / <sub>4</sub> 730	MQ27PE	2.0	0.9	MX27P	0.9	0.4
33 875	34 <sup>3</sup> / <sub>4</sub> 883	MQ33PE	2.5	1.1	MX33P	1.0	0.5
54 1370	54 <sup>3</sup> / <sub>4</sub> 1391	MQ54PE	4.0	1.8	MX54P	1.6	0.7
63 1585	62 <sup>3</sup> / <sub>4</sub> 1594	MQ63PE	4.5	2.0	MX63P	1.8	0.8
74 1690	74 <sup>3</sup> / <sub>4</sub> 1899	MQ74PE	5.5	2.5	MX74P	2.2	1.0
86 2195	86 <sup>3</sup> / <sub>4</sub> 2203	MQ86PE	6.5	2.9	MX86P	2.5	1.1

Nominal Height (in.) (mm)	Actual Height* (in.) (mm)	MetroMax Q Steel Model No.	POST FOR STEM CASTER				
			Approx. Pkd. Wt. (lbs.) (kg)		MetroMax i Polymer Model No.	Approx. Pkd. Wt. (lbs.) (kg)	
13 370	13 <sup>3</sup> / <sub>4</sub> 349	MQ13UPE	1.0	0.5	MX13UP	0.5	0.2
27 685	27 <sup>3</sup> / <sub>4</sub> 705	MQ27UPE	2.0	0.9	MX27UP	0.9	0.4
33 875	33 <sup>3</sup> / <sub>4</sub> 857	MQ33UPE	2.5	1.1	MX33UP	1.0	0.5
54 1370	53 <sup>3</sup> / <sub>4</sub> 1365	MQ54UPE	4.0	1.8	MX54UP	1.6	0.7
63 1585	61 <sup>3</sup> / <sub>4</sub> 1568	MQ63UPE	4.5	2.0	MX63UP	1.8	0.8
70 1778	69 <sup>3</sup> / <sub>4</sub> 1765	MQ70UPE	5.0	2.3			
74 1690	73 <sup>3</sup> / <sub>4</sub> 1873	MQ74UPE	5.5	2.5	MX74UP	2.3	1.0
86 2195	85 <sup>3</sup> / <sub>4</sub> 2178	MQ86UPE	6.5	2.9	MX86UP	2.5	1.4

Replacement Leveling Foot:  
Model No. RPM3-FOOT

Replacement Post Cap for Steel Post:  
Model No. RPMQS-POSTCAP

Replacement Post Cap for Polymer Post:  
Model No. RPMXS-POSTCAP

Replacement MetroMax Q Wedges  
Model No. MQ9985 Bag of 4



Replacement MetroMax Q Wedges MQ9985

### NOTE: Compatibility with existing Metro polymer mat shelving systems

- MQ9985 wedges are compatible with original MetroMax Q shelves and posts.
- The post centers on MetroMax Q have been changed to allow interchangeability with MetroMax i™ shelves. MetroMax Q shelves manufactured within or after April 2009 are not compatible with Q shelves made prior to April 2009.
- MetroMax Q is not compatible with original MetroMax manufactured prior to April 2009.
- Posts listed in above table (ex. MQ74PE, MX74PE) can be used with original MetroMax Q shelves made prior to April 2009.

## Post Clamp

Adds stability by joining posts of two separate units together. With it, each unit is supported by four posts and buttressed by the adjacent unit.

**Model No. 9994X**



## Foot Plate

Use to add stability to the shelving unit or to bolt units to the floor.

**Model No. Zinc 9993Z**

**Model No. Stainless Steel 9993S**



## Stem Casters

A variety of stem casters are offered for MetroMax i™ mobile applications.

Stem caster models include bumpers.



Replacement Bumper M9992DBX





# MODEL DFG-200-ES Full-Size Convection Oven



Project \_\_\_\_\_

Item No. \_\_\_\_\_

Quantity \_\_\_\_\_

Extra depth baking compartment - accepts five 18" x 26" standard full-size baking pans in left-to-right or front-to-back positions.

All data is shown per oven section, unless otherwise indicated.

Refer to operator manual specification chart for listed model names.

DFG-200-ES

### EXTERIOR CONSTRUCTION

- Stainless steel front, top, and sides
- Dual pane thermal glass windows encased in stainless steel door frames
- Powder-coated door handle with simultaneous door operation
- Triple-mounted pressure lock door design with turnbuckle assembly
- Ball bearing slide out front control panel for easy servicing
- 1" solid block plus 1" mineral fiber insulation for a total of 2" of insulation

### INTERIOR CONSTRUCTION

- Full angle-iron frame
- Double-sided porcelainized baking compartment liner (16 gauge)
- Stainless steel combustion chamber
- Single inlet blower wheel
- Five chrome-plated racks, eleven rack positions with a minimum of 1-5/8" (41mm) spacing
- Interior halogen lights

### OPERATION

- Direct fired gas system
- Electronic spark ignition control system
- Removable inshot burners
- Internal pressure regulator
- Manual gas service cut-off switch located on the front of the control panel
- Solid state thermostat with temperature control range of 200°F (93°C) to 500°F (260°C)
- Two speed fan motor
- 3/4 horsepower blower motor with automatic thermal overload protection
- Control area cooling fan

### STANDARD FEATURES

- SSD - Solid state digital control with LED display, Cook & Hold and Pulse Plus®
- 25" (635mm) adjustable stainless steel legs (for single units)
- 6" (152mm) adjustable stainless steel legs (for double sections)
- Three year parts and two year labor warranty
- Five year limited oven door warranty\*

\* For all international markets, contact your local distributor.



### OPTIONS AND ACCESSORIES

(AT ADDITIONAL CHARGE)

#### ■ Legs/casters/stands:

- 6" (152mm) seismic legs
- 6" (152mm) casters
- 4" (102mm) low profile casters (double only)
- 25" (635mm) stainless steel stand w/rack guides
- 29" (737mm) stainless steel, fully welded open stand with pan supports

#### ■ Controls:

- SSI-D - Solid state infinite control w/digital timer
- SSI-M - Solid state infinite control w/manual timer

#### ■ Gas hose w/quick disconnect restraining device:

- 48" (1219mm) hose
- 36" (914mm) hose
- Stainless steel oven liner
- Extra oven racks
- Stainless steel solid back panel
- Gas manifold (for double sections)
- Prison package (includes security control panel and stainless steel back)
- Flue connector
- Direct vent

### OPTIONS AND ACCESSORIES

(AT NO CHARGE)

- Solid stainless steel doors

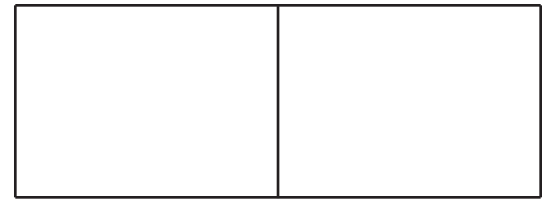


Fuller Middle School  
Framingham, MA

Item #: 24  
Quantity: 2

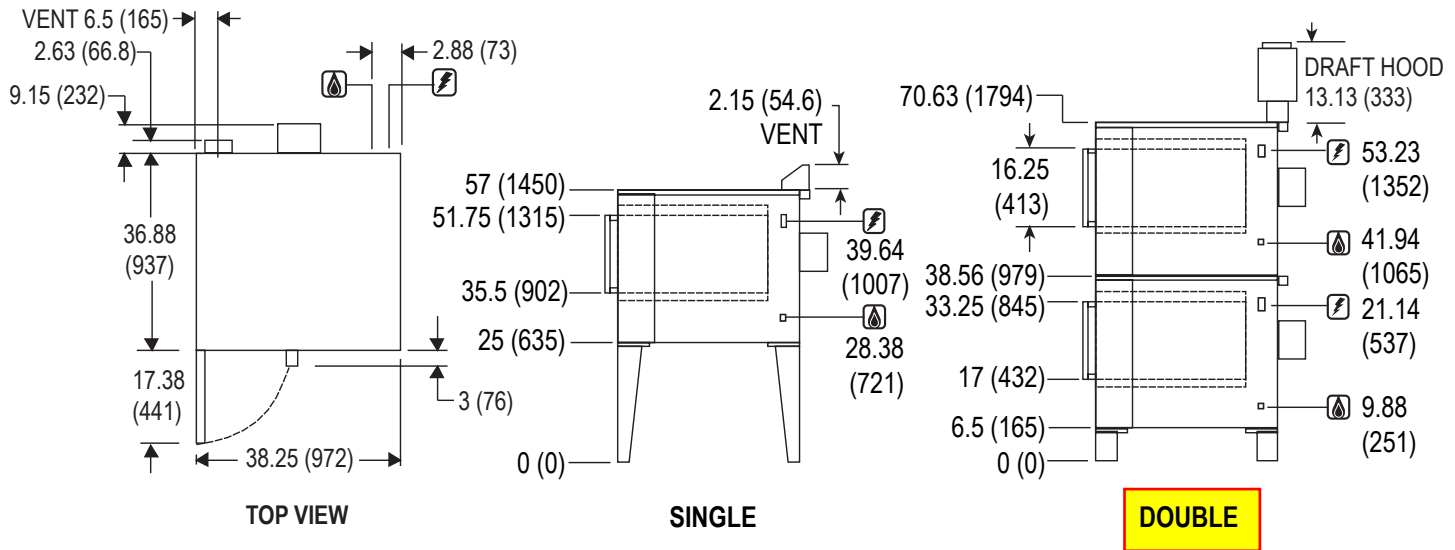


# DFG-200-ES



APPROVAL/STAMP

DIMENSIONS ARE IN INCHES (MM)



**SHORT FORM SPECIFICATIONS** - Provide Blodgett full-size, bakery depth convection oven model DFG-200-ES, (single/double) compartment. Each compartment shall have porcelainized/stainless steel liner and shall accept five 18" x 26" standard full-size bake pans in left-to-right or front-to-back positions. Stainless steel front, top and sides. Doors shall be (solid stainless steel/dual pane thermal glass windows) with single powder-coated handle and simultaneous operation. Unit shall be gas heated with electronic spark ignition and shall cook by means of a direct fired system with a gas shutoff switch on the front of the control panel. Air in baking chamber distributed by single inlet blower wheel powered by a two-speed, 3/4 HP motor with thermal overload protection. Each chamber shall be fitted with two halogen lamps, five chrome-plated removable racks and removable crumb trays. Control panel shall be recessed with solid state digital control with LED display, Cook & Hold and Pulse Plus. Provide three years parts, two year labor and five year door warranty. Provide options and accessories as indicated.

**DIMENSIONS:**

- Floor space 38-1/4" (972mm) W x 36-7/8" (937mm) D
- Product clearance 0" from combustible and non-combustible construction
- Interior 29" (737mm) W x 20" (508mm) H x 28-1/4" (718mm) D

**If oven is on casters:**

- Single Add 4-1/2" (114mm) to all height dimensions
- Double Height dimensions remain the same
- Double Low Profile Subtract 2.5" (64mm) from all height dimensions

**GAS SUPPLY:**

- 3/4" NPT
- Manifold Pressure:
  - Natural - 3.5" W.C.
  - Propane - 10" W.C.
- Inlet Pressure:
  - Natural - 7.0" W.C. min. - 10.5" W.C. max.
  - Propane - 11.0" W.C. min. - 13.0" W.C. max.

**MAXIMUM INPUT:**

- Single 50,000 BTU/hr (14.6 Kw)
- Double 100,000 BTU/hr (29.2 Kw)

**POWER SUPPLY:**

- 115 VAC, 1 phase, 8 Amp, 60 Hz., 2-wire with ground, 3/4 H.P., 2 speed motor, 1120 and 1680 RPM
- 6' (1.8m) electric cord set furnished on 115 VAC ovens only
- 230V CE model, 1 phase, 3 Amp, 50 Hz., 2-wire with ground, 1/2 H.P., 1 speed motor, 1440

Blodgett recommends a Pass & Seymour, model 2097, GFCI due to the use of a variable frequency drive. Must be hard wired in some cases.

**MINIMUM ENTRY CLEARANCE:**

- Uncrated 32-1/16" (814mm)
- Crated 37-1/2" (953mm)

**SHIPPING INFORMATION:**

- Approx. Weight:**
  - Single 590 lbs. (268 kg)
  - Double 1095 lbs. (497 kg)
- Crate sizes:** 37-1/2" (952mm) x 43-1/2" (1105mm) x 51-3/4" (1315mm)

**NOTE:** The company reserves the right to make substitutions of components without prior notice



Fuller Middle School  
 Framingham, MA

Item #: 24  
 Quantity: 2





# ULTIMATE RESTAURANT RANGE 36" SERIES

### Standard Features

- Commercial gas range 36" wide with a 37" high cooking top
- 4" Stainless steel front rail, stainless steel front and sides
- Front located manual gas shut-off to entire range
- One year No Quibble, 24/7 parts and labor warranty
- Factory installed Regulator
- Four (4) removable, cast iron grate tops (rear holds up to 14" stock pot)
- Standing pilot for open top burners
- Battery spark ignition for oven bases

### Optional 33K Non-clog Burners (Burner Option 1)

- (6) patented, one piece, lifetime clog free, cast iron burners
- 33,000 BTU NAT

### Optional Wavy Grates (Burner Option 2)

- Cast bowl design for better efficiency
- Allows full use of entire range top
- Available only with 27K BTU Non-clog burners

### Optional Cast Iron Star/Saute' Burners (Burner Option 3)

- (6) 33,000 BTU NAT star burners
- Port arrangement allows for even distribution of flame

### Optional Split Burner Configuration (Burner Option 4)

- (3) Star/Saute' burners in front and (3) standard 33K burners in rear

### Optional 5 Burner Configuration (Burner Options 5 and 6)

- Combine (2) Pyromax burners in the rear with either (3) standard 33K burners (Opt 5) or (3) star 33K burners (Opt 6) in the front

### Optional Pyromax Burners (Burner Option 7)

- 40,000 BTU NAT
- PATENTED high output, three piece, easy clean Non-clog burner
- Built in port protection drip ring
- Group of 4 burners available

### Optional Griddle Top (L or R)

- 12", 24" or 36" Available
- 1/2" thick cold rolled steel griddle plate
- Manual or thermostatically controlled

### Optional Charbroiler (L or R)

- 24" or 36" Available
- Removable, cast iron grates

Configure your own custom spec sheet  
and model number at  
**www.BuildMyRange.com.**  
Refer to AutoQuotes for list pricing.



(4361D Shown)



Job \_\_\_\_\_  
Item# \_\_\_\_\_

## CONSTRUCTION SPECIFICATIONS

**Exterior Finish:** Stainless steel front, sides and shelf standard.

**RangeTop:-** 27" deep cooking surface. Center-to-center measurements between burners not less than 12", side-to-side or front-to-back. A removable one piece drip tray is provided under burners to catch grease drippings.

**Flue Riser:** 22.5" flue riser standard with heavy duty shelf. Optional 10" and 5" flue riser available without shelf.

**Oven Door:** Spring assisted, counterweight door.

**Oven Interior:** Double sided, full porcelain enamel oven cavity for superior cleanability and corrosion protection. Coved corners for easy cleaning and enhanced airflow eliminating hot/cold spots.

**Legs:** 6" stainless steel adjustable legs standard (casters optional)

**Pressure Regulator:** Factory installed.

### Available Base Combinations

D, A, C, HxxxxD, HxxxxA

### Standard Oven Models (D)

45,000 BTU NAT oven with standing pilot and thermostat range of 175°F to 550°F (79°C to 288°C). Porcelain enamel interior measuring 14" high x 26" wide x 26.5" deep. Full sized pans fit both ways. One rack with two position side rails.

### Convection Oven Models (A):

32,000 BTU NAT convection oven with standing pilot and thermostat range of 175°F to 550°F (79°C to 288°C). Porcelain enamel interior measuring 14" high x 26" wide x 24" deep. Three racks with five position side rails. 1/2 hp, 1710 rpm, 60 cycle, 115V AC, high efficiency, permanent split phase motor with permanent lubricated ball bearings, overload protection and Class "B" insulation. On/Off switch to allow CO base to operate as a standard oven.

### Stainless Steel Cabinet (C)

Stainless steel cabinet base. Optional no-charge doors that open from the center.

### Hybrid Electric Standard Oven (HxxxxD)

4.5 kW electrically heated oven, with all the same base features of the gas standard oven at left (D).

### Hybrid Electric Convection Oven (HxxxxA)

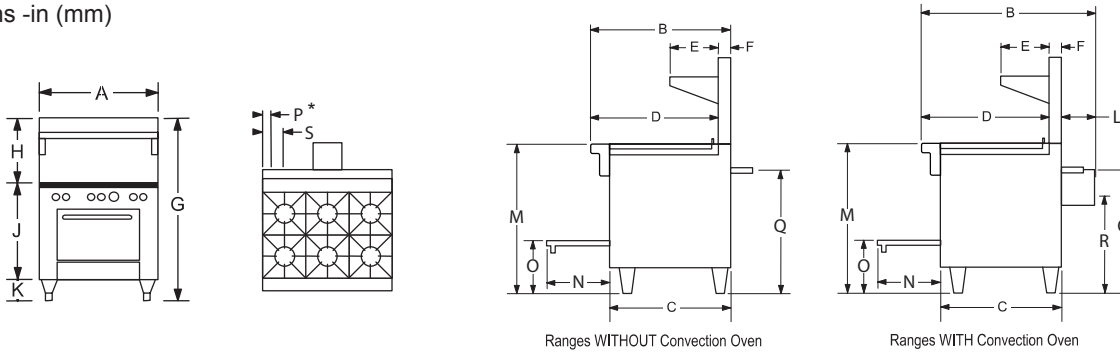
6 kW electrically heated oven, with all the same base features of the gas standard oven above (A).



Fuller Middle School  
Framingham, MA

Item #: 25  
Quantity: 1

Dimensions -in (mm)



MODELS	EXTERIOR											COOK TOP	DOOR OPENING	OVEN BOTTOM	3/4" GAS CONN.		ELECTRIC	
	WIDTH A	DEPTH B	C	D	E	F	G	H	J	K	L				M	N	O	P*
436_D, H436_D	36.50" (927)	34.00" (864)	29.75" (756)	31.00" (787)	10.00" (254)	2.75" (70)	59.50" (1511)	22.50" (572)	31.00" (787)	6.00" (152)	-	37.00" (940)	15.50" (394)	13.00" (330)	3.25" (83)	30.25" (768)	-	-
436_A, H436_A	36.50" (927)	42.13" (1070)	29.75" (756)	31.00" (787)	10.00" (254)	2.75" (70)	59.50" (1511)	22.50" (572)	31.00" (787)	6.00" (152)	8.25" (210)	37.00" (940)	15.50" (394)	13.00" (330)	3.25" (83)	30.25" (768)	24.00" (610)	6.00" (152)

MODELS	OVEN INTERIOR			CRATE SIZE			CUBIC VOLUME	CRATED WEIGHT
	WIDTH	DEPTH	HEIGHT	WIDTH	DEPTH	HEIGHT		
436_D, H436_D	26.00" (660)	26.50" (673)	14.00" (356)	58.00" (1473)	48.00" (1219)	44.00" (1118)	70.9 cu. ft 2.01cu.m.	660 lbs. 300 kg.
436_A, H436_A	26.00" (660)	24.00" (610)	14.00" (356)					

\*Gas Connection will be located on opposite side of optional griddle/charbroiler location (if optional griddle/charbroiler is located on the left, the gas connection will be moved to the right side).  
 Configure your own custom spec sheet and model number at [www.BuildMyRange.com](http://www.BuildMyRange.com).  
 Refer to AutoQuotes for list pricing.

UTILITY INFORMATION

BTUs EACH BURNER	STD NON-CLOG	STAR/SAUTE'	WAVY NON-CLOG	PYROMAX	(A) CNV OVEN PER CAVITY	(D) STD OVEN PER CAVITY	GRIDDLE 12"	GRIDDLE 24"	GRIDDLE 36"	CHARBROILER 24"	CHARBROILER 36"	HOT TOP 12"
NAT	33K	33K	27K	40K	32K	45K	18K	48K	64K	64K	96K	24K
LP	24K	24K	24K	31K	30K	40K	18K	48K	64K	64K	96K	24K

**GAS:**  
 - One 3/4" female connection.  
 - Required minimum inlet pressure  
 - Natural gas 7" W.C.  
 - Propane gas 11" W.C.

**ELECTRICAL:** (for Gas models with convection ovens)  
 - Standard -115/60/1 furnished with 6' cord with 3-prong plug. Total max amps 5.9 per convection oven base.  
 - Optional -208/60/1, 50/60/1 phase. Supply must be wired to junction box with terminal block located at rear. Total max amps 2.7.  
**ELECTRICAL:** (For Optional Hybrid Electric Ovens)  
 H436\_D - 208/60/1- 39 amps, 220/60/1-37 amps, 240/60/1-34 amps  
 H436\_A - 208/60/1-32 amps, 220/60/1-31 amps, 240/60/1-27 amps

MISCELLANEOUS

- If using Flex-Hose, the I.D. should not be smaller than 3/4" and must comply with ANSI Z 21.69.
- If casters are used with flex hose, a restraining device should be used to eliminate undue strain on the flex hose.
- For installation on combustible floors 6" high legs or casters are required. Minimum clearance from combustible construction is 10" on sides and rear for all units except charbroilers. Charbroiler units are for use in noncombustible locations ONLY.
- Rear clearance to noncombustible construction is 10" for charbroilers and 0" for all other tops and bases. Side clearance to noncombustible constructions is 0" on all units.
- Recommended - Install under vented hood.
- Check local codes for fire, installation and sanitary regulations.
- If the unit is connected directly to the outside flue, an A.G.A approved down draft diverter must be installed at the flue outlet of the oven.
- Two speed motors are not available on Restaurant Range Convection Ovens.

**NOTICE:** Southbend has a policy of continuous product research and improvement. We reserve the right to change specifications and product design without notice. Such revisions do not entitle the buyer to corresponding changes, improvements, additions or replacements for previously purchased equipment.

OPTIONS AND ACCESSORIES

- 5" flue riser
- 10" Flue Riser
- 3/4" quick disconnect with flexible hose complies with ANSI Z 21.69 (specify 3ft, 4ft, 5ft)
- Casters-all swivel-front with locks
- Hot Top plate - plate replaces 2 Open burners
- Cabinet base doors (No Charge)
- Extra Oven Racks
- Various salamander & cheesemelter mounts available. (Please refer to the price list)
- Rear step up burners
- Flame Failure available (Contact factory for available model numbers)
- Battery spark ignition for open tops, charbroilers, griddles and hot tops

INTENDED FOR COMMERCIAL USE ONLY.  
 NOT FOR HOUSEHOLD USE

**G****SIRIUS II DOUBLE GAS BOILERLESS CONVECTION STEAMER**

JOB NAME: \_\_\_\_\_

ITEM NO.: \_\_\_\_\_

NO. REQUIRED: \_\_\_\_\_

**MODELS**

- Sirius II-8** - two Sirius II-4 (four pan) steamers
- Sirius II-10** - one Sirius II-4 (four pan) and one Sirius II-6 (six pan) steamer
- Sirius II-12** - two Sirius II-6 (six pan) steamers

**DESCRIPTION**

Sirius II is a Market Forge convection/ circulating boilerless steam oven with automatic water-fill, featuring internally preheated water for fast recovery, clean water reservoir system, and rear drain. Sirius II models are efficiently heated by a burner external to the water reservoir. Sirius II steamers use 27,000 BTU per compartment.

**COOKING COMPARTMENT**

Operation occurs from steam generated in the cooking compartment. The walls and ceiling of the cooking compartment are heated to reduce steam condensation and to reheat and revitalize partially condensed steam. The steamer cavity has a convection fan to increase steam velocity and provide efficient steam distribution throughout the cavity. Steam is pulled past the cooking pans, then forced against the heated cooking chamber walls to be reheated. The cooking compartment is constructed of cast aluminum with a food-grade non-stick hard anodized finish. The compartment acts as a heat sink, allowing for heat retention, quick recovery, and reduced energy consumption.

**STANDARD FEATURES****Controls:**

- 4-Position cooking mode selector: OFF and 3 mode steaming - soft poach, traditional steam, high heat steam: or can be set to custom specifications up to 230°F (110°C)
- Clean probe indicator light
- Heating indicator light
- 60-minute timer
- Pulls out for easy service access

**Construction:**

- 304 Stainless, #4 finish (Cabinet)
- 356 Aluminum cast cooking compartment with hard-anodized finish

**Insulated Doors:**

- Safety shut-offs are provided by a hidden magnetic door switch, low water/high limit heat switch, temperature probe, water sensing probe and water-fill timer

**Other:**

- Manual front drain valve
- Internally preheated incoming water for quick recovery
- Redundant safety systems
- One-year parts and service



Sirius II-8

Sirius II-10

Sirius II-12

**SHIPPING WEIGHT**

- **Sirius II-8** - 450 lbs (204 kg)
- **Sirius II-10** - 475 lbs (215 kg)
- **Sirius II-12** - 500 lbs (227 kg)

**OPTIONS & ACCESSORIES**

(at additional charge)

**■ Pans & Covers**

- 12" x 20" pan cover
- 12" x 20" x 1" solid pan
- 12" x 20" x 1" perforated pan
- 12" x 20" x 2-1/2" solid pan
- 12" x 20" x 2-1/2" perforated pan
- 12" x 20" x 4" solid pan
- 12" x 20" x 4" perforated pan
- 12" x 20" x 6" solid pan
- 12" x 20" x 6" perforated pan

**■ Stands, Racks & Casters**

- MSS - Mobile stand w/slide out shelf and under shelf
- SSS - Stationary stand w/slide out shelf and under shelf
- STSS - 12" tall stationary stand (Sirius II-8 only)
- STSM - 16-5/8" tall mobile stand (Sirius II-8 only)
- Pan rack assembly for MSS and SSS
- Set of 4 casters, 2 with brakes

**■ Quick Disconnect Gas Hose**

- 48" long
- 60" long
- Prison package, includes lockable stainless steel hinged control cover, tamper proof screws, (2) 4" adjustable front flanged feet
- Heat and water side shield
- Water hose kit - 60" line with quick disconnect

**FOOD SERVICE EQUIPMENT**  
 Gas Boilerless Steamer
**MARKET FORGE**
**Fuller Middle School**  
**Framingham, MA**

 Item #: 26  
 Quantity: 2

# G

## SIRIUS II DOUBLE GAS BOILERLESS CONVECTION STEAMER

### DETAILS & DIMENSIONS

#### SPECIFICATIONS

	Sirius II-8	Sirius II-10	Sirius II-12
<b>Voltage</b>	120V	120V	120V
<b>BTU's</b>	27,000	27,000	27,000
<b>Gas NPT</b>	1/2"	1/2"	1/2"

#### GAS PRESSURE & CONNECTION

- Natural - 3.5" WC required, not to exceed 13.5"
- Propane - 9" WC required, not to exceed 13.5"
- Gas pipe size: 1/2" NPT required as a minimum

#### CAPACITY

Pans	Sirius II-8	Sirius II-10	Sirius II-12
12" x 20" x 2.5"	8	10	12
12" x 20" x 4"	4	6	8
12" x 20" x 6"	2	3	4

#### WATER SUPPLY & DRAIN

Good quality water feed is the responsibility of the owner. Water quality must be within the following general guidelines.

TDS: 40-125 ppm      Hardness: 35-100 ppm      pH: 7.0 - 8.5  
 Silica: <13 ppm      Chlorides: <25 ppm      Chlorine: <0.2 ppm  
 Chloramine: <0.2 ppm

The best defense against poor water quality is a water treatment system designed to meet your water quality conditions.

Pressure: 25(min)-50(max) PSI  
 Connections: Trough drain: 1/2 MNTP    Drain out: 1" FNPT  
 Water: 3/4" male garden hose

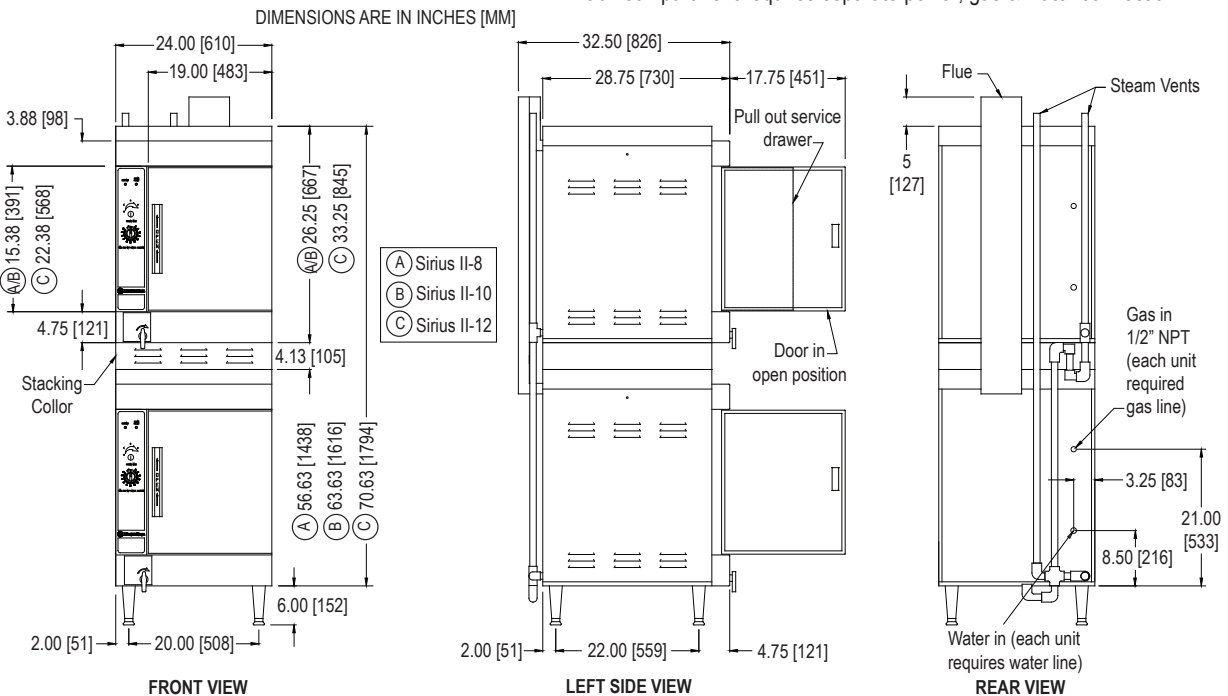
Appliance to be installed with backflow protection according to federal, state or local codes.

The drain piping must consist of temperature resistant material, greater than 160°F, and be of adequate diameter not to cause flow restriction. Improper materials may deform and cause restrictions, thus affecting performance.

#### NOTES

- Each single compartment has a separate rear exiting drain plumbed directly into the stacked steamers main drain/vent line.
- 4" clearance left mandatory, right and rear is recommended.
- Location near a floor drain is recommended.
- 4" stacking collar between units (included when ordered)
- Single and stacked units require hood for ventilation of flue products
- Each compartment requires separate power, gas & water connection.

FOOD SERVICE EQUIPMENT  
Gas Boilerless Steamer



The manufacturer reserves the right to modify materials and specifications without notice.

PRINTED IN U. S. A.  
 SPEC SHEET: 14-0073 Rev G (1/17)



# MARKET FORGE



Fuller Middle School  
 Framingham, MA

Item #: 26  
 Quantity: 2

Add SF18-S scale feeder cartridge

MODELS:

## SF165

Aqua-Pure<sup>®</sup> Commercial Series

SPEC # \_\_\_\_\_

QUANTITY \_\_\_\_\_

### APPLICATION

## SCALE CONTROL



### AT A GLANCE

Aqua-Pure<sup>®</sup> ScaleGuard HT provides consistent Recipe Quality Water<sup>®</sup> with reduced sediment and chlorine taste and odor. Operating cost savings from the controlled and metered addition of scale-inhibitors reduces the ability of calcium and magnesium to precipitate as hard scale in both high and low-temperature applications, including ice machines, coffee, tea, espresso brewers, and steamers\*.

- ScaleGuard HT, SF165 combines chlorine taste and odor reduction with sediment reduction, and protection from the harmful effects of scale formation at flow rates to 3.34 gpm (12.6 lpm) for 35,000 gallons (132,000 liters).

### PRODUCT BENEFITS

- Reduced sediment and chlorine for equipment protection and great tasting hot and cold beverages and ice.
- A forced-feed orifice carefully controls and meters the addition of a proprietary scale inhibitor to reduce scale build-up on evaporator plates and heating coils.
- Unmatched scale reduction performance in equipment from ice machines to equipment heating water to temperatures over 200°F (93°C). (not tested or certified by NSF)
- Revolutionary dual-zone **Integrated Membrane Pre-Activated Carbon Technology** ("IMPACT") filtration media combines a membrane in series with premium activated carbon to provide superior throughput and cartridge life.
- Certified by NSF to Standard 42 for Class 1 sediment reduction and chlorine taste and odor reduction.
- SQC - Sanitary Quick Change - encapsulated water cartridge design allows for fast and easy change-outs with a 1/4 turn while minimizing the possibility of leakage and contamination.
- FDA CFR-21 and/or NSF compliant materials provide assurance of safety.
- 3/4" FNPT inlet and outlet ports allow direct or easily-adaptable connections to existing plumbing lines.
- System includes a pressure gauge, inlet shut-off valve, and outlet check valve for simple installation and operation.
- Exhausted cartridges may be incinerated.

### PRODUCT SPECIFICATIONS

Model Number	Part Number	Reduction Claims	Micron Rating	Capacity	Service Flow Rate	Application	Replacement Cartridge	Sizing
SF165	56186-01	Sediment, Chlorine Taste & Odor, Scale	3	35,000 gallons (132,000 liters)	3.34 gpm (12.6 lpm)	Normal to Hard Water	HF65 56134-07 HF8-S 55821-06 Cartpak 56138-11	Ice: Cubers to 1200 lbs (544 kg); Flakers to 2400 lbs (1089 kg). Coffee Brewers and Steamers to demand flow rates of 3.34 gpm (12.6 lpm)

\* Periodic acid de-liming of heating coils is recommended for steamer applications



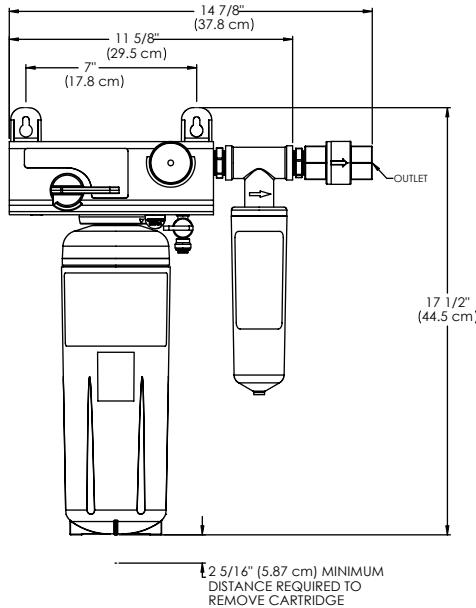
# Aqua-Pure® Commercial Products

SPEC # \_\_\_\_\_  
 QUANTITY \_\_\_\_\_  
 MODEL NUMBER \_\_\_\_\_  
 PART NUMBER \_\_\_\_\_



SF165

## PHYSICAL SPECIFICATIONS



- System includes a manifold with built-in pressure gauge, inlet water shut-off valve, outlet check valve, mounting bracket, the cartridge filter, and the scale-feeding system
- Inlet and outlet plumbing connections are 3/4" FNPT.
- Water cartridge is double o-ring seal type; scale feeder cartridge is single o-ring seal type.
- System maximum operating pressure of 125 psi (862 kPa) and a maximum operating temperature of 100°F (38°C).
- Recommended service flow rate is up to 3.34 gpm (12.6 lpm).
- Filter cartridge incorporates carbon block media protected by a pleated pre-filter membrane.
- The scale inhibitor, sumps, and filtration media are CFR-21 and/or NSF Standard 42 compliant
- Cartridges are sanitary in design, requiring no contact with the filter media during cartridge change-out.
- Filter cartridge requires no pre-activation.
- A NSF Performance Data Sheet (pds) is included.
- Shipping weight: 6 lbs (2.7 kg).
- Operating weight: 12 lbs (5.4 kg).

## INSTALLATION TIPS

- Shut off downstream equipment prior to installation of the system.
- Choose mounting location to support full system weight when operating.
- Do not exceed operating parameters for temperature or pressure.
- Do not install outdoors.
- For commercial use only.
- Install on cold water line only.

## LIMITED 5 YEAR WARRANTY

**IMPORTANT: Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system.** Systems certified for cyst reduction may be used on disinfected water that may contain filterable cysts. EPA Establishment Number 070595-CT-001.

**“CAUTION” To reduce the risks associated with water leakage, which if not avoided, may result in property damage - check with your plumbing professional to verify that water pressure is less than 125 psi (862 kPa).**

CUNO Incorporated recommends regularly scheduled maintenance and replacement of the filter cartridge(s) in order for the product to perform as advertised/sold. **Change the filter cartridge at least every 6 months.** CUNO shall not be liable for system failures due to improper maintenance.

CUNO makes no guarantees or warranties, expressed or implied, including, but not limited to, any implied warranty of merchantability or fitness for a particular purpose or implied warranty arising out of a course of dealing, custom, or usage of trade whatsoever with respect to these instructions. CUNO shall not under any circumstances be liable to the recipient of these instructions for any direct, indirect, special, incidental, or consequential loss or damages (including, but not limited to, loss of profits, revenue, business, opportunity, or goodwill) resulting from or in any way related to these instructions or the recipient's non-adherence to these instructions, regardless of the legal or equitable theory under which such loss or damages are sought, including breach of warranty or contract, negligence or strict liability.



Visit [www.nsf.org](http://www.nsf.org) for the claims associated with products that are NSF listed.



CUNO Incorporated  
 400 Research Parkway  
 Meriden, CT 06450, USA



Fuller Middle School  
 Framingham, MA

Item #: 27  
 Quantity: 2



# ND-2 Series

## Exhaust Only Hood

CaptiveAire's Premier Canopy

The ND-2 Series is a Type I, Wall Canopy Hood for use over 450°F, 600°F and 700°F cooking surface temperatures. The aerodynamic design includes a mechanical baffle and performance enhancing lip for exceptional capture and containment.

### Fully Integrated Package

CaptiveAire sells this hood as a stand-alone appliance to be integrated into a kitchen ventilation application, or provided as part of a FULLY INTEGRATED PACKAGE designed by CaptiveAire and pre-engineered for optimum performance. The package consists of the hood, an integral utility cabinet, factory pre-wired electrical controls, and a listed fire suppression system. Other options include a listed exhaust fan, a listed make-up air unit and listed, factory-built ductwork.



### Advantages

- **Exhaust Flow Rates:** Superior exhaust flow rates. A 4' Hood can operate at 150 CFM/ft or 600 total CFM. Available in single or back-to-back configurations.
- **ETL Listed:** ETL Listed for use over 450°F, 600°F and 700°F cooking surface temperatures, which provides flexibility in designing kitchen ventilation systems. ETL Listed to US and Canadian safety standards, ETL Sanitation Listed and built in accordance with NFPA 96.
- **Capture and Containment:** Insulated, double-wall rigid front has aerodynamic design that reduces radiant heat into kitchen, prevents condensation and provides exceptional capture and containment of cooking vapors. This is accomplished with the signature ND-2 "mechanical baffle" on the front of the hood's capture area and the "C-shaped" design of the hood's capture area. Mechanical baffle provides a built-in wiring chase for optimal positioning of electrical controls and outlets on the front face of the hood without penetrating capture area or requiring external chase way.
- **Convenient Design:** Factory pre-wired lighting to illuminate the cooking surface is accessible from the bottom of the hood. Fitted with UL Listed, pre-wired, incandescent light fixtures and tempered glass globes to hold up to a standard 100



Fuller Middle School  
Framingham, MA

Item #: 28  
Quantity: 1

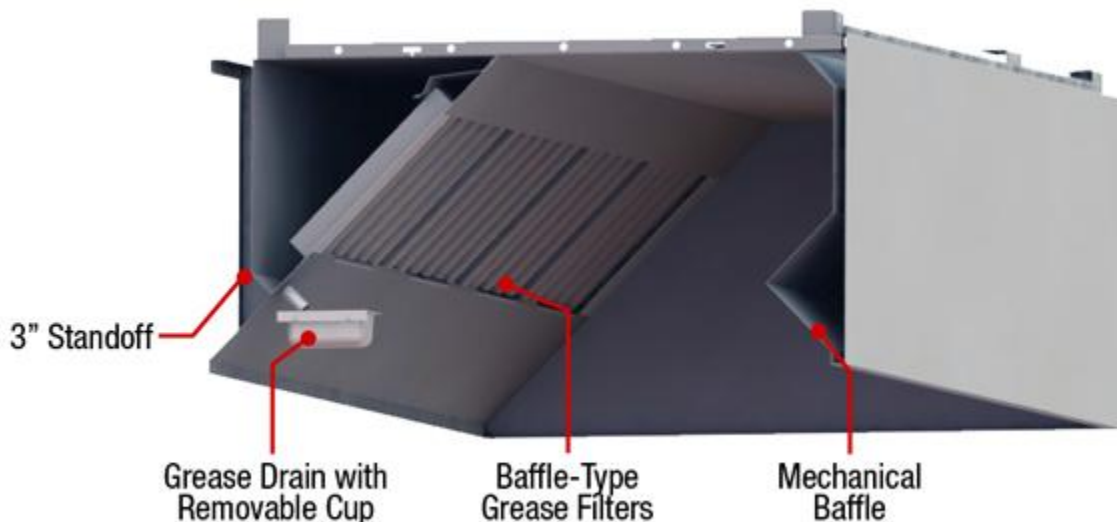
- **Construction:** Polished stainless steel on the interior and exterior of the front enhance aesthetics. Fully welded and polished front corners. Fabricated from Type 430 stainless steel with option of Type 304 available.
- **Channels:** Hood comes standard with structural channels on top and wrapper channels on the bottom.
- **Grease Extraction:** All hoods come standard with stainless steel baffle filters and a deep grease trough which allows for easy cleaning. Captrate Combo® and Captrate Solo® filters are optional. Grease drain system with removable 1/2 pint cup for easy cleaning. Standard filter stops eliminate gaps between filters.
- **Reduced Lead Times and Shipping Costs:** Produced on a high volume assembly line at one of five manufacturing facilities to reduce lead times and shipping costs.
- **Clearance to Combustibles:** Standard built in 3" rear standoff to meet NFPA 96 requirements, when installed in a wall application.
- **Controls:** Hoods can be equipped with modular utility cabinets and end standoffs. Optional listed light and fan control switches flush mounted and pre-wired through electrical chase way.
- **Optional Make-Up Air:** Up to 80% make-up air can be supplied through optional front and/or side plenums (ND-2 Series with PSP or AC-PSP Accessory).
- **Reduced Weight:** Rigid single wall end panels reduce weight.

## Performance

AVG. COOKING SURFACE TEMP. (°F)	CONFIGURATION	MIN. EXHAUST CFM / FT.
450°F - Ovens, Steamers, Kettles, Open-Burner Ranges, Griddles, Fryers	Single Wall Hood 2 Wall Hoods Back-to-Back	150 300
600°F - Gas Charbroilers, Electric Charbroilers, Woks	Single Wall Hood 2 Wall Hoods Back-to-Back	200 400
700°F - Mesquite Grills, Charcoal Charbroilers, Wood Burning Appliances	Single Wall Hood 2 Wall Hoods Back-to-Back	250 500

**Recommended Duct Sizing:** Exhaust - Based on 1500 FPM

## Features





## Options

**Utility Cabinet:** Listed for integral side mount and fabricated of same material as hood. Cabinet can house listed fire suppression system and listed, pre-wired electrical controls.

**Front Perforated Supply Plenum:** Provides low velocity make-up air for the kitchen and is discharged in front of the hood. Perforated diffuser plates allow for even air distribution and supply riser includes a volume damper for easy balancing. Side Perforated Supply Plenums can be added to optimize the air flow if necessary.

**Rear Make-Up Air Plenum:** Provides make-up air for the kitchen and is discharged below cooking equipment. Provides required clearance from limited combustibles per NFPA 96 Standards.

**Enclosure Panels:** Constructed of stainless steel. Sized to extend from hood top to ceiling, enclosing pipe and hanging parts.

**End Panels:** Should be used to maximize hood performance and eliminate the effects of cross drafts in kitchen. Units constructed of stainless steel and sized according to hood width and cooking equipment. Exposed edges hemmed for safety and rigidity.

**Roof Top Package:** Combination ETL Listed exhaust/supply air unit with factory prewired and mounted motors, trunkline and curb vented on exhaust side.

**Separate Exhaust and/or Make-Up Air Fans:** ETL Listed single exhaust fans and supply-air fans and curbs available.

**Fire Suppression System:** UL 300 fire suppression system.

**Lighting:** Recessed Incandescent, Recessed Fluorescent, Compact Fluorescent, LED, Recessed LED, Halogen

## Certifications

The ND-2 Model has been certified by ITS. This certification mark indicates that the product has been tested to and has met the minimum requirements of a widely recognized (consensus) U.S. and Canadian products safety standard, that the manufacturing site has been audited, and that the applicant has agreed to a program of periodic factory follow-up inspections to verify continued performance.

Models ND-2 are ETL Listed under file number 3054804-001 and complies with UL710, ULC710 and ULC-S646 Standards.





# UDS

provides unequalled cooking line  
versatility, flexibility & convenience

## UTILITY DISTRIBUTION SYSTEM

## One connection for all your utility needs

The CaptiveAire Utility Distribution System (UDS) is designed to meet all electrical and plumbing requirements for your kitchen appliances. A two compartment raceway houses the plumbing and electrical connections needed to meet your specific application.



### Available Models

- ▶ **UDI:** Island configuration with equipment connections on both sides
- ▶ **UDW:** Wall mounted with equipment connections on one side only

### Key Advantages

The Utility Distribution System allows greater flexibility over conventional utility connections and offers a cost-effective way to replace the custom designed wall built by contractors. Additional capacity for new equipment is provided with spare connection points built into the unit. Adding or changing equipment requires minimal effort.

- ▶ **Electrical Riser:** Main power connection is made to the main circuit breaker which has a shunt trip and is mounted in the electrical riser.
- ▶ **Bus bar systems:** Electrical power is fed through the main circuit breaker to the bus bar system in the raceway. Each appliance is fed from the bus bar through individually sized circuit breakers located along the raceway.
- ▶ **Wireway systems:** Electrical power is fed through a main circuit breaker to a distribution panel which contains individual branch breakers. Each appliance is fed from the individual breakers which are wired to each receptacle located along the raceway.
- ▶ **Plumbing Riser:** The plumbing riser houses manual (quarter-turn) shut-off valves for each incoming main supply line



Fuller Middle School  
Framingham, MA

Item #: 29  
Quantity: 1

## Product Features

- ▶ **Expandability:** All plumbing manifolds are provided with multiple plumbing stubs for future use. All electrical systems are designed for additional capacity for future expansion or upgrade of connected appliances.
- ▶ **Bus Bar Systems:** Individual circuit breakers mounted on interchangeable plates for ease of service and relocation.
- ▶ **Wireway:** Electrical distribution panel located in the riser is equipped with branch circuit breakers and sized for expansion.
- ▶ **Serviceability and Accessibility:** Lift out doors provide easy access to risers without moving cooking equipment. Removable panels provided along the length of the raceway allow access to either plumbing or electrical compartments.
- ▶ **Electric Outlook and Cord Sets:** All outlets are provided with moisture resistant covers and have been sized per NEMA standards. Each is supplied with a matching cord and plug set if these are not already supplied by the equipment manufacturer. Twist-lock sets are standard with the model UDI. Straight blade sets are standard with the model UDW.
- ▶ **Main Disconnect:** One point disconnect through a main circuit breaker equipped with a 120 VAC rated shunt trip provided in the riser.
- ▶ **Gas Solenoid Valve:** Electrical or Mechanical. Electrical valves provided with a manual reset button.
- ▶ **Shunt Trip:** Provided with each main breaker.
- ▶ **Appliance Protection:** Each electrical outlet connection is protected with an individual circuit breaker.
- ▶ **Dual Convenience Outlets:** Located at each riser with integral ground fault protection.
- ▶ **Fire/Fuel Shutoff:** In compliance with NFPA 96, terminal connection points provided for field wiring to the fire protection system to shut off fuel sources and power in the event of a fire.
- ▶ **CAD:** Customized CAD Drawings Provided

## Product Options

- ▶ **Remote Status Indicator Panel:** Lighted panel indicates status of breakers in wireway system.
- ▶ **Electric Outlets & Cord Sets:** Water tight pin and sleeve outlets and cords.
- ▶ **Light & Fan Switches:** located in riser.
- ▶ **Hood Control Panel:** built into riser.
- ▶ **Ground Fault Protection**
- ▶ **Prison Package**
- ▶ **Bumper Strips**
- ▶ **Emergency Kill Switch:** Single point shutdown of electrical power and electrical gas valves.
- ▶ **Swivel Connectors:** for gas equipment.
- ▶ **Plumbing Fixtures:** Pre-plumbed and installed faucets, mixing valves, hose reels.
- ▶ **Cable Restraints:** Available for mobile equipment.
- ▶ **Hinged Doors:** for internal access to risers.
- ▶ **Temperature/Pressure Gauges:** for hot/cold water main.

## Electrical

**Bus Bar Systems:** The electrical raceway shall be a four (4) conductor copper bus bar system having balanced load and phases and shall be completely isolated from the plumbing supply manifolds. Point of use circuit breakers shall be mounted on connection plates which are located on the peaked top of the raceway and protected by a water proof stainless steel hinged cover. The breakers shall be easily accessible to the operator. The connection plates shall be easily interchangeable with spare blank plates which shall be provided for future expansion or changes. A main circuit breaker with a built-in 120 VAC rated shunt trip shall be furnished in the electrical riser and require a single point incoming connection. Terminal block connections shall be provided for field interconnection between the shunt trip and the fire protection system for power shut-off in the event of a fire.

**Wireway Systems:** The electrical system shall consist of a main circuit breaker which feeds power to a distribution panel located in the electrical riser containing individual branch breakers. Each



in the event of a fire. All outlets shall be equipped with grounding type receptacles having specific NEMA polarized configurations and located on the under side (Model UDI) or front side (Model UDW) of the raceway at each equipment location. Outlets are matched to the cord and plug sets supplied with equipment. On the Model UDI, twist lock cord and plug sets are provided for equipment supplied without cords. On the Model UDW, straight blade cord and plug sets are provided for equipment supplied without cords.

**Main Circuit Breaker:**

15 to 600 Ampere, 1 or 3 phase  
120, 208, or 480 VAC System

**Branch Circuit Breaker:** 15 to 100 Ampere, 1 or 3 phase  
120, 208, or 408 VAC System

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## Plumbing

The plumbing compartment shall be completely isolated from the electrical with all piping labeled. Hot and cold water and steam supply and return manifolds shall be insulated. All incoming service connections shall be provided with 1/4 shut-off valve. Each branch connection shall be provided with 1/4 shut-off valve, color coded, and located at each equipment location. Color coded quick disconnect hoses are provided for connection to equipment. Hot and cold water piping, including branch connections, shall be type "L" copper tubing. All fittings will be copper sweat soldered (95-5 type). Gas and steam piping, including branch connections, shall be threaded black iron. There shall be a drip tee on the incoming gas end. The gas manifold shall be furnished with either an electrical or mechanical gas valve which shall be field interlocked with the fire protection system to shut off fuel sources in the event of a fire. Electrical gas valves shall be furnished with a manual gas reset button located in the UDS riser. Gas manifolds are sized for an inlet pressure of 7" WC for natural gas or 11" WC for LP. All plumbing components are UL, AGA and MA approved.



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## Gas

Manifold (single or looped): 3/4" to 3" IPS  
1/4 turn manual shut-off valve on manifold  
Quick disconnect hoses: 1/4" to 1-1/4", up to 6' long  
Quick disconnect fittings: 1/4" to 1-1/4" with 1/4 shut-off valves

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## Hot & Cold Water

Manifold: 3/4" to 1" IPS  
1/4 turn manual shut-off valve on manifold  
Quick disconnect hoses: 1/4" to 1", up to 6' long  
Quick disconnect fittings: 1/4" to 1" with 1/4 shut-off valves  
Steam Supply/Steam Return  
Steam Manifold: 3/4" to 3" IPS  
Condensate Return Manifold: 3/4" to 2" IPS  
1/4 turn manual valves on manifolds  
Quick disconnect hoses: 1/4" to 1-1/4", up to 6' long  
Quick disconnect fittings: 1/4" to 1-1/4" with 1/4 shut-off valves

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## Compressed Air

Manifold: 1/2" to 3/4" IPS  
1/4 turn manual shut-off valve on manifold  
Quick disconnect hoses: 1/4" to 1/2", up to 6' long  
Quick disconnect fittings: 1/4" to 1/2" with 1/4 shut-off valves

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## Certifications

The UDS Model has been certified by ITS. This certification mark indicates that the product has been tested to and has met



**Fuller Middle School**  
Framingham, MA

Item #: 29  
Quantity: 1

Model UDS is ETL Listed under file number 3054803-001 and complies with UL891 Standards and CSA C22.2, No. 31-M89 Standards.





# ND-2 Series

## Exhaust Only Hood

CaptiveAire's Premier Canopy

The ND-2 Series is a Type I, Wall Canopy Hood for use over 450°F, 600°F and 700°F cooking surface temperatures. The aerodynamic design includes a mechanical baffle and performance enhancing lip for exceptional capture and containment.

### Fully Integrated Package

CaptiveAire sells this hood as a stand-alone appliance to be integrated into a kitchen ventilation application, or provided as part of a FULLY INTEGRATED PACKAGE designed by CaptiveAire and pre-engineered for optimum performance. The package consists of the hood, an integral utility cabinet, factory pre-wired electrical controls, and a listed fire suppression system. Other options include a listed exhaust fan, a listed make-up air unit and listed, factory-built ductwork.



### Advantages

- **Exhaust Flow Rates:** Superior exhaust flow rates. A 4' Hood can operate at 150 CFM/ft or 600 total CFM. Available in single or back-to-back configurations.
- **ETL Listed:** ETL Listed for use over 450°F, 600°F and 700°F cooking surface temperatures, which provides flexibility in designing kitchen ventilation systems. ETL Listed to US and Canadian safety standards, ETL Sanitation Listed and built in accordance with NFPA 96.
- **Capture and Containment:** Insulated, double-wall rigid front has aerodynamic design that reduces radiant heat into kitchen, prevents condensation and provides exceptional capture and containment of cooking vapors. This is accomplished with the signature ND-2 "mechanical baffle" on the front of the hood's capture area and the "C-shaped" design of the hood's capture area. Mechanical baffle provides a built-in wiring chase for optimal positioning of electrical controls and outlets on the front face of the hood without penetrating capture area or requiring external chase way.
- **Convenient Design:** Factory pre-wired lighting to illuminate the cooking surface is accessible from the bottom of the hood. Fitted with UL Listed, pre-wired, incandescent light fixtures and tempered glass globes to hold up to a standard 100



Fuller Middle School  
Framingham, MA

Item #: 30  
Quantity: 1

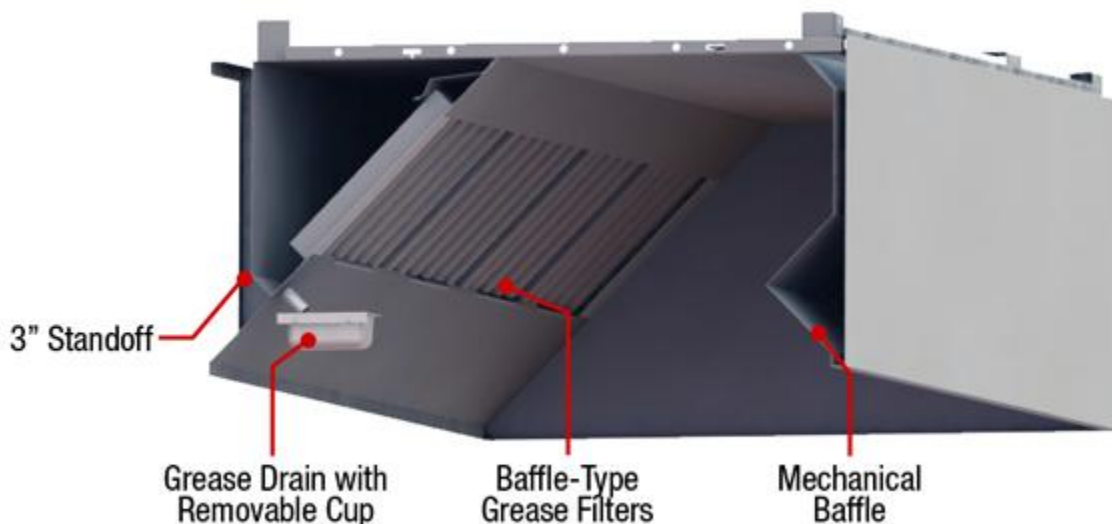
- **Construction:** Polished stainless steel on the interior and exterior of the front enhance aesthetics. Fully welded and polished front corners. Fabricated from Type 430 stainless steel with option of Type 304 available.
- **Channels:** Hood comes standard with structural channels on top and wrapper channels on the bottom.
- **Grease Extraction:** All hoods come standard with stainless steel baffle filters and a deep grease trough which allows for easy cleaning. Captrate Combo® and Captrate Solo® filters are optional. Grease drain system with removable 1/2 pint cup for easy cleaning. Standard filter stops eliminate gaps between filters.
- **Reduced Lead Times and Shipping Costs:** Produced on a high volume assembly line at one of five manufacturing facilities to reduce lead times and shipping costs.
- **Clearance to Combustibles:** Standard built in 3" rear standoff to meet NFPA 96 requirements, when installed in a wall application.
- **Controls:** Hoods can be equipped with modular utility cabinets and end standoffs. Optional listed light and fan control switches flush mounted and pre-wired through electrical chase way.
- **Optional Make-Up Air:** Up to 80% make-up air can be supplied through optional front and/or side plenums (ND-2 Series with PSP or AC-PSP Accessory).
- **Reduced Weight:** Rigid single wall end panels reduce weight.

## Performance

AVG. COOKING SURFACE TEMP. (°F)	CONFIGURATION	MIN. EXHAUST CFM / FT.
450°F - Ovens, Steamers, Kettles, Open-Burner Ranges, Griddles, Fryers	Single Wall Hood 2 Wall Hoods Back-to-Back	150 300
600°F - Gas Charbroilers, Electric Charbroilers, Woks	Single Wall Hood 2 Wall Hoods Back-to-Back	200 400
700°F - Mesquite Grills, Charcoal Charbroilers, Wood Burning Appliances	Single Wall Hood 2 Wall Hoods Back-to-Back	250 500

**Recommended Duct Sizing:** Exhaust - Based on 1500 FPM

## Features



## Options

**Utility Cabinet:** Listed for integral side mount and fabricated of same material as hood. Cabinet can house listed fire suppression system and listed, pre-wired electrical controls.

**Front Perforated Supply Plenum:** Provides low velocity make-up air for the kitchen and is discharged in front of the hood. Perforated diffuser plates allow for even air distribution and supply riser includes a volume damper for easy balancing. Side Perforated Supply Plenums can be added to optimize the air flow if necessary.

**Rear Make-Up Air Plenum:** Provides make-up air for the kitchen and is discharged below cooking equipment. Provides required clearance from limited combustibles per NFPA 96 Standards.

**Enclosure Panels:** Constructed of stainless steel. Sized to extend from hood top to ceiling, enclosing pipe and hanging parts.

**End Panels:** Should be used to maximize hood performance and eliminate the effects of cross drafts in kitchen. Units constructed of stainless steel and sized according to hood width and cooking equipment. Exposed edges hemmed for safety and rigidity.

**Roof Top Package:** Combination ETL Listed exhaust/supply air unit with factory prewired and mounted motors, trunkline and curb vented on exhaust side.

**Separate Exhaust and/or Make-Up Air Fans:** ETL Listed single exhaust fans and supply-air fans and curbs available.

**Fire Suppression System:** UL 300 fire suppression system.

**Lighting:** Recessed Incandescent, Recessed Fluorescent, Compact Fluorescent, LED, Recessed LED, Halogen

## Certifications

The ND-2 Model has been certified by ITS. This certification mark indicates that the product has been tested to and has met the minimum requirements of a widely recognized (consensus) U.S. and Canadian products safety standard, that the manufacturing site has been audited, and that the applicant has agreed to a program of periodic factory follow-up inspections to verify continued performance.

Models ND-2 are ETL Listed under file number 3054804-001 and complies with UL710, ULC710 and ULC-S646 Standards.





NEW TECHNOLOGY

# CUSTOMIZABLE INTERFACE

*CaptiveAire* continues to bring innovation to the market - introducing new state of the art controls for hood operation and lighting.

## USER FRIENDLY CONTROLS

- Digital Interface with LCD Screen
- Customizable Options via Microprocessor Control

## REDUCES INSTALLATION COST & COMPLEXITY

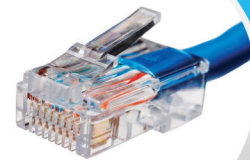
- Plug & Play Wiring between Digital Interface & Equipment
- Reduces High Voltage Wiring between Devices

## REMOTE MONITORING

- Equipment Status & Alarms Displayed
- Improves Service & Reliability

## INTEGRATED FEATURES

- Automatic Fan Activation
- Room Temperature Sensor
- Reset for Gas Valves
- Monitoring of Fan Overload Trips



*CAT-5 Cable Wiring*

Learn more about our ventilation products at  
[www.captiveaire.com](http://www.captiveaire.com)

## Demand Control Ventilation Specification

### Application:

The Demand Control Ventilation System (DCV) is designed to automatically reduce exhaust and supply airflow quantities, while ensuring hood performance is maintained. The DCV uses Variable Frequency Drives (VFD) and temperature sensors in the exhaust ducts to modulate the fans speed during cooking operation and maximize energy savings. The LCD screen interface provides fan(s) control, system configuration, and diagnostic information.

### Construction:

The DCV includes:

- Smart Controller
- LCD Screen Interface
- Duct Temperature Sensor(s)
- Variable Frequency Drive(s)

Controls shall be listed by ETL (UL 508A).

The system includes a LCD screen interface for fan(s) and hood lights control, wash control (if applicable), gas valve reset, programmable schedule, Max Air Override function, Preparation Time mode, Cool Down mode, and diagnostics including VFD status. The LCD screen shows descriptive plain text explaining the functions or values. The LCD screen interface will be installed on the face of the hood, on the face of the utility cabinet or on the face of a wall mounted control enclosure.

Control enclosure will be NEMA 1 rated and listed for installation inside of the exhaust hood utility cabinet. Control enclosure may be constructed of stainless steel or painted steel.

The smart controller will constantly monitor the exhaust air temperature through the riser mounted temperature sensor and modulate the fan speeds accordingly.

A room temperature sensor will also be provided for field installation in the kitchen space in order to start the fan(s) based on the fixed temperature differential between the room and the exhaust air in the duct rather than fixed set-points.

A Preparation Time Mode is available for morning operation: dedicated make-up air will be locked out only allowing the use of transfer air during this mode. Exhaust fan(s) will run at low CFM while maintaining a balanced kitchen pressure.

A Cool Down Mode is designed for equipment cool-down period at the end of the daily cooking operations: similarly to Preparation Time mode, dedicated make-up air will be locked out only allowing the use of transfer air during this mode. Exhaust fan(s) will run at low CFM while maintaining a balanced kitchen pressure.

Fan maximum/ minimum speeds will be adjustable for proper kitchen balance. Fan direction change is also available from the smart controller configuration menu without need for rewiring.

Duct Temperature Sensor(s) will be mounted in the exhaust hood riser(s). Temperature probe will be constructed of Stainless Steel. System will be factory pre-set to modulate fan speed within a range of 45°F for 600°F and 700°F cooking applications and a range of 5°F for 400°F cooking applications. Setpoints are fully adjustable through the LCD screen interface based on application needs.

The Max Air Override will have an adjustable timeout value.

The panels include color-coded wiring with as-built wiring diagrams and spare terminals controlled by the fire system micro switch. The panel is factory pre-wired to shut supply fans down in a fire condition. Options to turn ON the exhaust fans or turn off the hood lights in a fire condition will be configurable through the smart controller, but only through a password protected menu to prevent any changes after a fire inspection has been performed.





## Product Data

**A/AN Series**  
**A/CP Series**  
**A/3K Series**  
**A/1.8K Series**  
**A/20K Series**

Temperature Sensor

## Product Description

The A/10K-AN (Type III), A/10K-CP (Type II), A/3K, A/1.8K and A/20K Series temperature sensors are thermistor type sensors. These sensors provide a predictable output over a specified temperature range to meet each manufacturer's required input values. (See [www.workaci.com](http://www.workaci.com) for complete curve chart specifications)

These units are offered in Room, Room with Setpoint, Room with Override, Room with Setpoint and Override, and Room w/ Setpoint, Override, and RJ11 Jack, Stainless Steel Duct and Duct without Box, Immersion, Stainless Plate, Raw, Bendable Copper and Stainless Steel Rigid Averaging, Strap-On, Bullet Probe, Button Sensor, and Outdoor Air Configurations.

All ACI Room sensors may be ordered with an optional setpoint (see chart on the following page), override, or with a 4 pin RJ11 or 6 pin RJ12 communication jack with terminal blocks, for remote programming. These units are also available with a 1/8" RS232 Stereo Jack.

These products are covered by ACI's Five (5) Year Limited Warranty, which is located in the front of ACI'S SENSORS & TRANSMITTERS CATALOG or can be found on ACI's web site, which is: [www.workaci.com](http://www.workaci.com).

## Product Specifications

Sensor Output	10K Ohms @ 77°F (25°C) Type III 10K Ohms @ 77°F (25°C) Type II 3K Ohms @ 77°F (25°C) 1.8K Ohms @ 77°F (25°C) 20K Ohms @ 77°F (25°C)
Accuracy (0 to 70°C)	+/-0.2°C (+/-0.36°F)
Stability	+/- 0.13°C (0.23°F)
Operating Temperature Range	-40 to 302°F (-40 to 150°C)
Operating Humidity	0 to 90% RH non-condensing
Interchangeability	+/- 0.2°C (+/-0.36°F)
Power Dissipation Constant	3 mW / °C
For sensors with Display option, see LCD Series Temp display cut sheet	

## Thermistor



### Attributes

- Offer high accuracy and interchangeability over a wide temperature range.
- Higher resistance output relative to Platinum RTD's
- Non-polarity sensitive
- CE approval for thermistors except for:
  - Averaging sensors
  - LCDs and units that have leads longer than 3 meters

### Applications

- OEM / Industrial
- Light Industrial
- DDC Systems



Made in the USA

Automation Components, Inc.  
 2305 Pleasant View Rd.  
 Middleton, WI 53562  
 PH: (608) 821-2595



Fuller Middle School  
 Framingham, MA

Item #: 34  
 Quantity: 1

TEMPERATURE

RELATIVE HUMIDITY

PRESSURE

CURRENT

GAS SENSORS

ACCESSORIES

INTERFACE DEVICES

**Ordering Information**

**AN=type III**

**CP=type II**

**A/AN, A/CP, A/3K, A/1.8K or A/20K** (choose configuration below)

-Configuration	-Length	-Enclosure Type	-Optional Plenum Wire
<b>D</b> (Duct)	4", 8", 12", 18"	PB, GD, BB, 4X, EH	
<b>DO</b> (Duct without Box)	4", 8", 12", 18"	-----	6'CL2P, 10'CL2P, 20'CL2P
<b>I</b> (Immersion w/ well)	2.5", 4", 6"	PB*, GD, BB, 4X, EH	
<b>INW</b> (Immersion no well)	2.5", 4", 6"	PB*, GD, BB, 4X, EH	
<b>A</b> (Copper Averaging)	8', 12', 24'	PB, GD, BB, 4X, EH	
<b>FA</b> (Flex. Cable Averaging)	8', 12', 24'	PB, GD, BB, 4X, EH	
<b>RA</b> (Rigid Averaging)	18", 24", 36"	PB, GD, BB, 4X, EH	
<b>S</b> (Strap)	-----	PB*, GD, 4X	
<b>O</b> (Outdoor Air)	-----	EH, BB, 4X	
<b>SP</b> (Stainless Plate)			
<b>W</b> (Raw Potted Sensor)			
<b>W-6'</b> (Raw w/ 6' Leads)			
<b>BP</b> (Bullet Probe)			
<b>BP-20'Z</b> (BP w/20' of Zip Wire)			
<b>BBS</b> (Brass Button Sensor)			
<b>SBS</b> (Stainless Button Sensor)			
<b>PBS</b> (Plastic Button Sensor)			

**Enclosure Key**

**PB = Plastic Box**  
**GD = Galvanized Box**  
**BB = NEMA 3R**  
**4X = NEMA 4X**  
**EH = Euro Housing (Weather tight)**

\*Please note that the -PB (Plastic Box) is rated to 140° F and may not be suitable for high temperature applications.

**Example: A/AN-D-4"-PB**

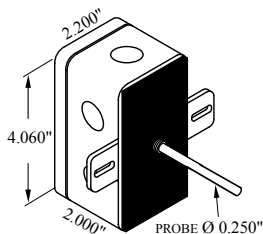
**Room configurations:**

Configuration	Communication Jack	Pot Value*	Setpoint Indicator*	Pot Action*	Display
<b>R</b> - Room	<b>RJ4</b> (4 Pin RJ11)	400 5K	Cool   Warm	DA (Direct)	( ) No Display (Standard)
<b>RS*</b> - Room w/ Setpoint	<b>RJ6</b> (6 Pin RJ12)	1K 8.5K	55 to 85	RA (Reverse)	(DF) LCD Display (Degrees F)
<b>RO</b> - Room w/ Override	<b>RS232</b> (Stereo Jack)	2K 10K	10 to 30°C		(DC) LCD Display (Degrees C)
<b>RSO*</b> -Room w/ Setpoint & Override		3K 20K			
		100K			

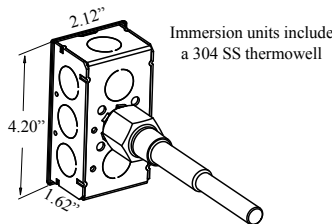
Room Sensors with\* require setpoint specs (value, indication, and action) and are not listed on your packing slip or invoice.

**Example: A/CP-RSO- 10K- Cool/Warm-DA**

**Standard enclosure defaults:**

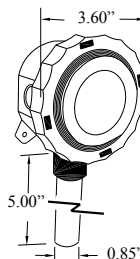


**Duct**  
(Plastic Box)

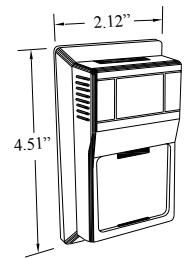


**Immersion**  
(Galvanized Box)

Immersion units include a 304 SS thermowell



**Outdoor Air**  
(Euro Enclosure)



**Room**



by Tyco Fire Suppression & Building Products

# R-102™ RESTAURANT FIRE SUPPRESSION SYSTEMS

Data/Specifications

## FEATURES

- Low pH Agent
- Proven Design
- Reliable Gas Cartridge Operation
- Aesthetically Appealing
- UL Listed – Meets Requirements of UL 300
- ULC Listed – Meets Requirements of ULC/ORD-C1254.6
- CE Marked

## APPLICATION

The ANSUL® R-102™ Restaurant Fire Suppression System is an automatic, pre-engineered, fire suppression system designed to protect areas associated with ventilating equipment including hoods, ducts, plenums, and filters. The system also protects auxiliary grease extraction equipment and cooking equipment such as fryers; griddles and range tops; upright, natural charcoal, or chain-type broilers; electric, lava rock, mesquite, or gas-radiant char-broilers; and woks.

The system is ideally suitable for use in restaurants, hospitals, nursing homes, hotels, schools, airports, and other similar facilities.

Use of the R-102 system is limited to indoor applications or locations that provide weatherproof protection within tested temperature limitations. The regulated release and tank assemblies must be mounted in an area where the air temperature will not fall below 32 °F (0 °C) or exceed 130 °F (54 °C). The system must be designed and installed within the guidelines of the UL/ULC Listed Design, Installation, Recharge, and Maintenance Manual.

## SYSTEM DESCRIPTION

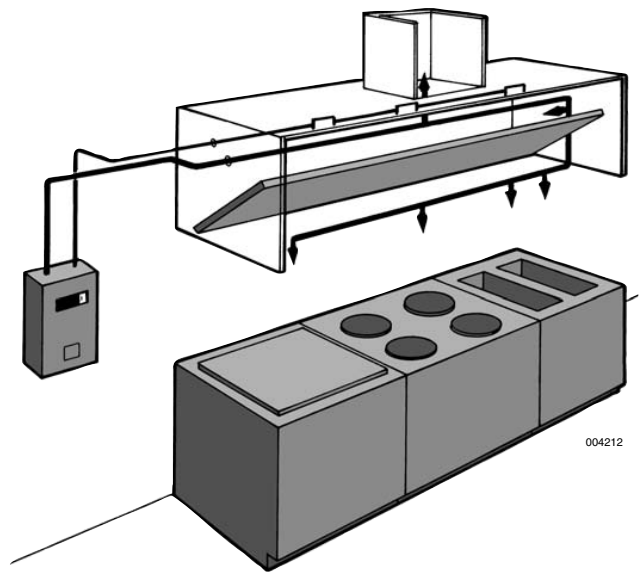
The restaurant fire suppression system is a pre-engineered, wet chemical, cartridge-operated, regulated pressure type with a fixed nozzle agent distribution network. It is listed with Underwriters Laboratories, Inc. (UL/ULC).



004215

The system is capable of automatic detection and actuation as well as remote manual actuation. Additional equipment is available for building fire alarm panel connections, electrical shutdown and/or interface, and mechanical or electrical gas line shut-off applications.

The detection portion of the fire suppression system allows for automatic detection by means of specific temperature-rated alloy type fusible links, which separate when the temperature exceeds the rating of the link, allowing the regulated release to actuate.



004212

A system owner's guide is available containing basic information pertaining to system operation and maintenance. A detailed technical manual, including system description, design, installation, recharge and resetting instructions, and maintenance procedures, is available to qualified individuals.

The system is installed and serviced by authorized distributors that are trained by the manufacturer.

The basic system consists of an ANSUL AUTOMAN® regulated release assembly which includes a regulated release mechanism and a wet chemical storage tank housed within a single enclosure. Nozzles with blow-off caps, detectors, cartridges, agent, fusible links, and pulley elbows are supplied in separate packages in the quantities needed for fire suppression system arrangements.

Additional equipment includes a remote manual pull station(s), mechanical and electrical gas valves, and electrical switches for automatic equipment and gas line shut-off. Accessories can be added such as alarms, warning lights, etc., to installations where required.

Additional tanks and corresponding equipment can be used in multiple arrangements to allow for larger hazard coverage. Each tank is limited to a listed maximum amount of flow numbers.



004213

## COMPONENT DESCRIPTION

**Wet Chemical Agent** – The extinguishing agent is a mixture of organic salts designed for rapid flame knockdown and foam securement of grease related fires. It is available in plastic containers with instructions for wet chemical handling and usage.

**Agent Tank** – The agent tank is installed in a stainless steel enclosure or wall bracket. The tank is constructed of stainless steel.

Tanks are available in two sizes: 1.5 gallon (5.7 L) and 3.0 gallon (11.4 L). The tanks have a working pressure of 110 psi (7.6 bar), a test pressure of 330 psi (22.8 bar), and a minimum burst pressure of 660 psi (45.5 bar).

The tank includes an adaptor/tube assembly. The adaptor assembly includes a chrome-plated steel adaptor with a 1/4 in. NPT female gas inlet, a 3/8 in. NPT female agent outlet, and a stainless steel agent pick-up tube. The adaptor also contains a bursting disc seal which helps to prevent the siphoning of agent up the pipe during extreme temperature variations.

**Regulated Release Mechanism** – The regulated release mechanism is a spring-loaded, mechanical/pneumatic type capable of providing the expellant gas supply to one, two, or three agent tanks depending on the capacity of the gas cartridge used. It contains a factory installed regulator deadset at 110 psi (7.6 bar) with an external relief of approximately 180 psi (12.4 bar). It has automatic actuation capabilities by a fusible link detection system and remote manual actuation by a mechanical pull station.

The regulated release mechanism contains a release assembly, regulator, expellant gas hose, and agent storage tank housed in a stainless steel enclosure with cover. The enclosure contains knock-outs for 1/2 in. conduit. The cover contains an opening for a visual status indicator.

It is compatible with mechanical gas shut-off devices; or, when equipped with a field or factory-installed switch and manual reset relay, it is compatible with electric gas line or appliance shut-off devices.

**Regulated Actuator Assembly** – When more than two agent tanks (or three 3.0 gallon (11.4 L) tanks in certain applications) are required, the regulated actuator is available to provide expellant gas for additional tanks. It is connected to the cartridge receiver outlet of the regulated release mechanism providing simultaneous agent discharge. It contains a regulated actuator deadset at 110 psi (7.6 bar) with an external relief of approximately 180 psi (12.4 bar). It has automatic actuation capabilities using pressure from the regulated release mechanism cartridge.

The regulated actuator assembly contains an actuator, regulator, expellant gas hose, and agent tank housed in a stainless steel enclosure with cover. The enclosure contains knockouts to permit installation of the expellant gas line.

**Discharge Nozzles** – Each discharge nozzle is tested and listed with the R-102 system for a specific application. Nozzle tips are stamped with the flow number designation (1/2, 1, 2, or 3). Each nozzle must have a metal or rubber blow-off cap to keep the nozzle tip orifice free of cooking grease build-up.

**Agent Distribution Hose** – Kitchen appliances manufactured with or resting on casters (wheels/rollers) may include an agent distribution hose as a component of the suppression system. This allows the appliance to be moved for cleaning purposes without disconnecting the appliance fire suppression protection. The hose assembly includes a restraining cable kit to limit the appliance movement within the range (length) of the flexible hose.

**Flexible Conduit** – Flexible conduit allows for quicker installations and the convenience of being able to route the cable over, under and around obstacles. Flexible conduit can be used as a substitute for standard EMT conduit or can be used with EMT conduit.

Flexible conduit can be used only with the Molded Remote Manual Pull Station.

**Pull Station Assembly** – The remote manual pull station is made out of a molded red composite material. The red color makes the pull station more readily identifiable as the manual means for fire suppression system operation.

The pull station is compatible with the ANSUL Flexible Conduit.

## APPROVALS

- UL/ULC Listed
- CE Marked
- New York City Department of Buildings
- LPCB
- TFR1
- Marine Equipment Directive (MED)
- DNV
- ABS
- Lloyd's Register
- Meets requirements of NFPA 96 (Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment)
- Meets requirements of NFPA 17A (Standard on Wet Chemical Extinguishing Systems)

## ORDERING INFORMATION

Order all system components through your local authorized ANSUL Distributor.

## SPECIFICATIONS

An ANSUL R-102 Fire Suppression System shall be furnished. The system shall be capable of protecting all hazard areas associated with cooking equipment.

### 1.0 GENERAL

#### 1.1 References

- 1.1.1 Underwriters Laboratories, Inc. (UL)
  - 1.1.1.1 UL Standard 1254
  - 1.1.1.2 UL Standard 300
- 1.1.2 Underwriters Laboratories of Canada (ULC)
  - 1.1.2.1 ULC/ORD-C 1254.6
- 1.1.3 National Fire Protection Association (NFPA)
  - 1.1.3.1 NFPA 96
  - 1.1.3.2 NFPA 17A

#### 1.2 Submittals

- 1.2.1 Submit two sets of manufacturer's data sheets
- 1.2.2 Submit two sets of piping design drawings

#### 1.3 System Description

- 1.3.1 The system shall be an automatic fire suppression system using a wet chemical agent for cooking grease related fires.
- 1.3.2 The system shall be capable of suppressing fires in the areas associated with ventilating equipment including hoods, ducts, plenums, and filters as well as auxiliary grease extraction equipment. The system shall also be capable of suppressing fires in areas associated with cooking equipment, such as fryers; griddles and range tops; upright, natural charcoal, or chain-type broilers; electric, lava rock, mesquite or gas-radiant char-broilers; and woks.
- 1.3.3 The system shall be the pre-engineered type having minimum and maximum guidelines established by the manufacturer and listed by Underwriters Laboratories (UL/ULC).
- 1.3.4 The system shall be installed and serviced by personnel trained by the manufacturer.
- 1.3.5 The system shall be capable of protecting cooking appliances by utilizing either dedicated appliance protection and/or overlapping appliance protection.

#### 1.4 Quality Control

- 1.4.1 Manufacturer: The R-102 Restaurant Fire Suppression System shall be manufactured by a company with at least forty years experience in the design and manufacture of pre-engineered fire suppression systems. The manufacturer shall be ISO 9001 registered.
- 1.4.2 Certificates: The wet agent shall be a specially formulated, aqueous solution of organic salts with a pH range between 7.7 – 8.7, designed for flame knock-down and foam securement of grease-related fires.

#### 1.5 Warranty, Disclaimer, and Limitations

- 1.5.1 The pre-engineered restaurant fire suppression system components shall be warranted for five years from date of delivery against defects in workmanship and material.

#### 1.6 Delivery

- 1.6.1 Packaging: All system components shall be securely packaged to provide protection during shipment.

#### 1.7 Environmental Conditions

- 1.7.1 The R-102 system shall be capable of operating within a temperature range of 32 °F to 130 °F (0 °C to 54 °C).

## 2.0 PRODUCT

### 2.1 Manufacturer

- 2.1.1 Tyco Fire Suppression & Building Products, One Stanton Street, Marinette, Wisconsin 54143-2542, Telephone (715) 735-7411.

### 2.2 Components

- 2.2.1 The basic system shall consist of an ANSUL AUTOMAN regulated release assembly which includes a regulated release mechanism and a wet chemical storage tank housed within a single enclosure. Nozzles, blow-off caps, detectors, cartridges, agent, fusible links, and pulley elbows shall be supplied in separate packages in the quantities needed for fire suppression system arrangements. Additional equipment shall include remote manual pull station, mechanical and electrical gas valves, and electrical switches for automatic equipment and gas line shut-off, and building fire alarm control panel interface.
- 2.2.2 Wet Chemical Agent: The extinguishing agent shall be a specially formulated, aqueous solution of organic salts with a pH range between 7.7 – 8.7, designed for flame knockdown and foam securement of grease related fires.
- 2.2.3 Agent Tank: The agent tank shall be installed in a stainless steel enclosure or wall bracket. The tank shall be constructed of stainless steel. Tanks shall be available in two sizes; 1.5 gallon (5.7 L) and 3.0 gallon (11.4 L). The tank shall have a working pressure of 110 psi (7.6 bar), a test pressure of 330 psi (22.8 bar), and a minimum burst pressure of 660 psi (45.5 bar). The tank shall include an adaptor/tube assembly containing a burst disc union.
- 2.2.4 Regulated Release Mechanism: The regulated release mechanism shall be a spring-loaded, mechanical/pneumatic type capable of providing the expellant gas supply to one or two agent tanks depending on the capacity of the gas cartridge used or three 3.0 gallon (11.4 L) agent storage tanks in certain applications. It shall contain a factory installed regulator deadset at 110 psi (7.6 bar) with an external relief of approximately 180 psi (12.4 bar).  
It shall have the following actuation capabilities: automatic actuation by a fusible link detection system and remote manual actuation by a mechanical pull station. The regulated release mechanism shall contain a release assembly, regulator, expellant gas hose, and agent storage tank housed in a stainless steel enclosure with cover. The enclosure shall contain knockouts for 1/2 in. conduit. The cover shall contain an opening for a visual status indicator.  
It shall be compatible with mechanical gas shut-off devices; or, when equipped with a field or factory-installed switch(es), it shall be compatible with electric gas line or appliance shut-off devices, or connections to a building fire alarm control panel.
- 2.2.5 Regulated Actuator Assembly: When more than two agent tanks or three agent tanks in certain applications are required, the regulated actuator shall be available to provide expellant gas for additional tanks. It shall be connected to the cartridge receiver outlet of the regulated release mechanism providing simultaneous agent discharge. The regulator shall be deadset at 110 psi (7.6 bar) with an external relief of approximately 180 psi (12.4 bar). The regulated actuator assembly shall contain an actuator, regulator, expellant gas hose, and agent tank housed in a stainless steel enclosure with cover. The enclosure shall contain knockouts to permit installation of the expellant gas line.
- 2.2.6 Discharge Nozzles: Each discharge nozzle shall be tested and listed with the R-102 system for a specific application. Nozzles tips shall be stamped with the flow number designation (1/2, 1, 2, or 3). Each nozzle shall have a metal or rubber blow-off cap to keep the nozzle tip orifice free of cooking grease build-up.



## SPECIFICATIONS

### 2.0 PRODUCT (Continued)

#### 2.2 Components (Continued)

- 2.2.7 Distribution Piping: Distribution piping shall be Schedule 40 black iron, chrome-plated, or stainless steel conforming to ASTM A120, A53, or A106.
- 2.2.8 Detectors: The detectors shall be the fusible link style designed to separate at a specific temperature.
- 2.2.9 Cartridges: The cartridge shall be a sealed steel pressure vessel containing either carbon dioxide or nitrogen gas. The cartridge seal shall be designed to be punctured by the releasing device supplying the required pressure to expel wet chemical agent from the storage tank.
- 2.2.10 Agent Distribution Hose: An optional agent distribution hose shall be available for kitchen appliances manufactured with or resting on casters (wheels/rollers). This shall allow the appliance to be moved for cleaning purposes without disconnecting the appliance fire suppression protection. Hose assembly shall include a restraining cable kit to limit the appliance movement within the range (length) of the flexible hose.
- 2.2.11 Flexible Conduit: The manufacturer supplying the Restaurant Fire Suppression System shall offer flexible conduit as an option to rigid EMT conduit for the installation of pull stations and/or mechanical gas valves. The flexible conduit shall be UL Listed and include all approved components for proper installation.
- 2.2.12 Pull Station Assembly: The Fire Suppression System shall include a remote pull station for manual system actuation. The pull station shall be designed to include a built-in guard to protect the pull handle. The pull station shall also be designed with a pull handle to allow for three finger operation and shall be red in color for quick visibility.

### 3.0 IMPLEMENTATION

#### 3.1 Installation

- 3.1.1 The R-102 fire suppression system shall be designed, installed, inspected, maintained, and recharged in accordance with the manufacturer's listed instruction manual.

#### 3.2 Training

- 3.2.1 Training shall be conducted by representatives of the manufacturer.

► Indicates revised information

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**tyco**  
Fire Suppression  
& Building Products

www.ansul.com  
One Stanton Street  
Marinette, WI 54143-2542

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Form No. F-2004004-7



Fuller Middle School  
Framingham, MA

Item #: 35  
Quantity: 1

**ITEM 37**

**CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION:**      **Cook's Table with Sink**

**NO CUT SHEET AVAILABLE**

**CONSTRUCTION FEATURES:**

Make - Fabricate per General Construction this Section

Size - 8'-6" x 30" x 36" high; overshelf 8'-6" long with shelf at 54" above floor; 20" deep shelf; 18" x 20" x 10" deep integral sink basin

Construction - 14 gauge stainless steel top and sink basin over angle frame, edges formed in turndown, six legs with gussets, adjustable feet, flanged feet at the corners for securing to floor, two crossrails and partial undershelf. Overshelf shall be 16 gauge stainless steel, constructed similar to a wall shelf, channel reinforced, and welded to three extended rear table legs with support webs, and supported in integrally welded inverted gussets with sleeved joints for rigidity.

Accessories - Drawer assembly, deck mounted faucet set and a 2" lever waste outlet. Provide four cast brushed aluminum enclosed outlet boxes for mounting of electric outlets in setback position below the overshelf complete with GFI receptacle and stainless steel cover plate. Mount below the overshelf and pre-wire thru upright to junction box mounted below the table

Item 38

**CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION:**      **Mobile Work Table**

**Quantity: 1**

**Size: 60"x 30"**

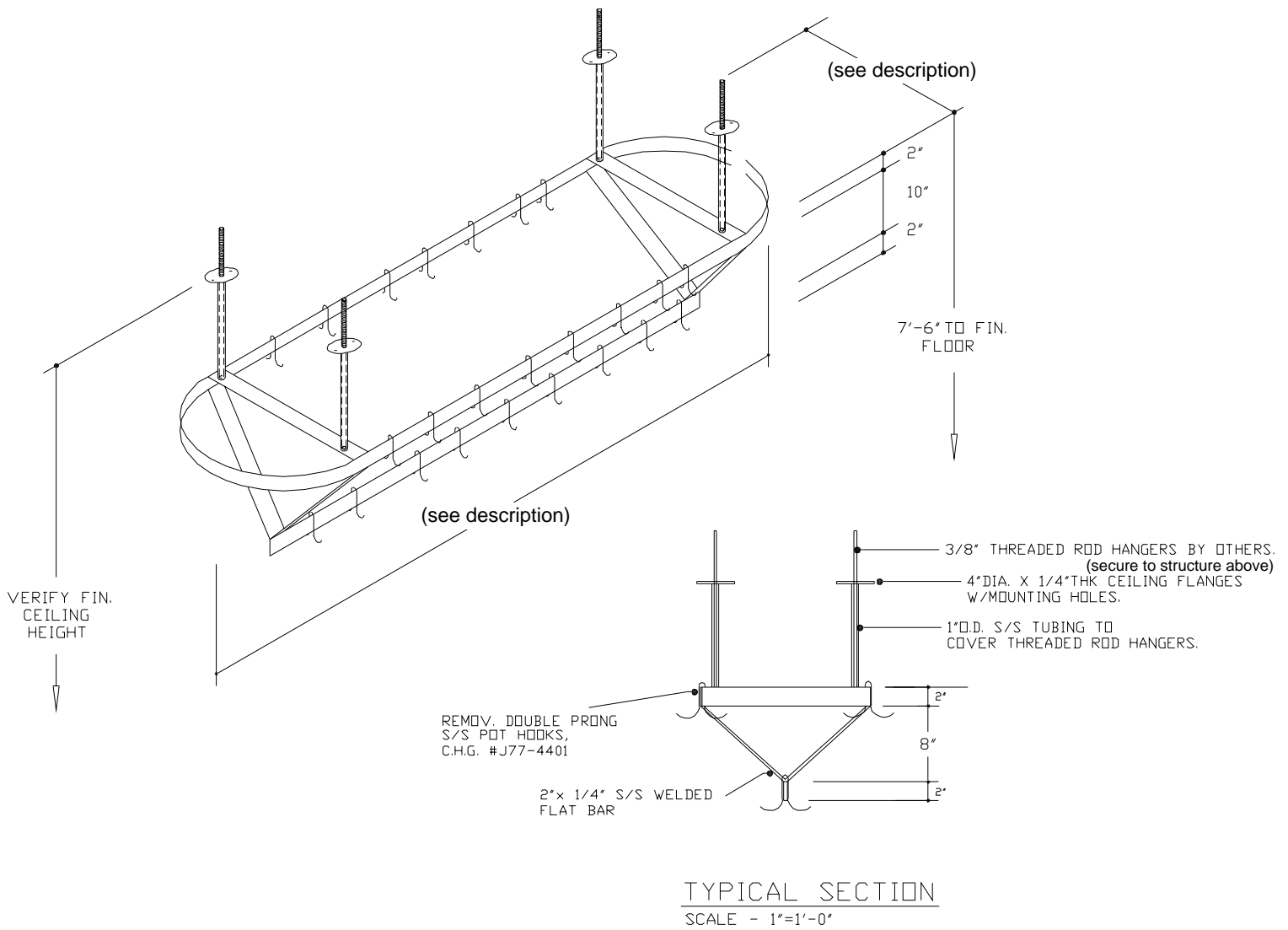
**NO CUT SHEET AVAILABLE**

**CONSTRUCTION FEATURES:**

Make - Fabricate per General Construction this Section

Size - 60" x 30" x 36" high

Construction - 14 gauge stainless steel top over angle frame with edges turned down and mounted on four legs with gussets, 5" diameter swivel casters, two with brakes, and full undershelf and drawer assembly.



**CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION: Ceiling mounted utensil rack**

72" x 24"; mounted with rails at 78" & 90" above floor

**CONSTRUCTION FEATURES:**

- 1/4" x 2" stainless steel bar stock throughout
- Two bar upper rail with full radiused ends
- Single lower rail
- Reinforcing straps
- Suspended from the overhead structure on four hangers
- Provide unit with forty-eight Component Hardware J77-4401 stainless steel double pot hooks.

## EXTRA WIDE REACH-IN WARMING CABINETS

Full Door	Half Door
HS-1D-1-EW-PT HS-2D-1-EW-PT	HS-1D-1-EW-PT-HD HS-2D-1-EW-PT-HD
HSA-1D-1-EW-PT HSA-2D-1-EW-PT	<b>HSA-1D-1-EW-PT-HD</b> HSA-2D-1-EW-PT-HD

- Equipped with Secure-Temp 1.0™ Technology™

- 3 Year Parts & Labor Warranty Plus an Additional 2 Year Compressor Warranty

- Exclusive 2 Year Warranty on Santoprene Door Gaskets

# VICTORY ULTRASPEC™

FEATURING: **SecureTemp**  
1.0™

Secure-Temp 1.0™ is the industry's first and only full service temperature monitoring solution for your kitchen. Secure-Temp 1.0™ is standard on all Victory models and is HACCP compliant & meets NAFEM's data protocol.

**There are NO software or monthly monitoring fees.** Optional add on kits are available for additional units.

## STANDARD FEATURES

- Secure-Temp 1.0™ Technology
- Full Electronic Control System
- Adjustable Electronic Temp Control from 80°F to 180°F
- Built-in, Adjustable Humidity Control Vent
- Safety Shielded Strip Type Heating Elements
- Externally Mounted Blower Maintains Even Temperatures
- Foamed-in-Place Polyurethane Insulation
- Heavy Duty Cylinder Locks
- Santoprene Door Gaskets with Exclusive 2 Year Warranty
- Self-Closing Doors with 120° Hold Open Feature
- Cam-Lift Hinges, Guaranteed for Life
- Ergonomically Correct Door Handles, Guaranteed for Life
- 6" High, Adjustable Stainless Steel Legs
- A Series has 6" High Standard Black Legs
- Proximity Door Switch Activates Interior Incandescent Lighting
- One Piece, Snap-In Magnetic Door Gasket(s)
- Stainless Steel Interior Door Liner
- Three (3) Chrome Plated Wire Shelves per Cabinet Section
- 10' Cord & Plug Standard



HS-2D-1-EW-PT-HD

## OPTIONS & ACCESSORIES

- **6" or 3" Overall Height Casters (Set of 4)**
- Correctional Facilities Options
- Stainless Steel Shelves
- 6" Stainless Steel Kick Plate
- Exterior Laminate Décor
- Finished Back with Rear Grille
- Stainless Steel Case Back and Shroud
- Optional Voltages (single section only)

### CABINET CONSTRUCTION

The cabinet front and doors are constructed of heavy gauge, polished stainless steel to maintain an attractive appearance after years of heavy use. Polyurethane foam insulation throughout ensures the ultimate in energy efficiency.

### DOOR CONSTRUCTION

The doors are heavy gauge, polished stainless steel with a stainless steel interior liner. Each door is provided with a cylinder lock and ergonomically correct vertical handle. The door hinges are self-closing and have a hold-open feature at 120° which facilitates product loading. Proximity switches energize the recessed interior incandescent lighting when the door is opened.

### HEATING SYSTEM

The safety shielded, "strip type" heaters located at the bottom of the cabinet interior are precisely controlled by the V-TEMP™ electronic control with a temperature range from 80°F to 180°F. An externally mounted blower system ensures even temperatures throughout the cabinet interior. A built-in, adjustable humidity control vent allows the operator to maintain a moist or more dry environment.

### INTERIOR STORAGE ARRANGEMENTS

Each cabinet section is provided with three (3) heavy-duty, chrome plated wire shelves. The shelves are adjustable in one inch increments. A wide door opening allows for the use of a variety of optional pan slide configurations including 18" x 26" and 12" x 20" pans.

### ELECTRONIC CONTROL SYSTEM

The easy to use V-TEMP™ Control is provided standard with a two year parts and labor warranty. This durable, water resistant microprocessor monitors and controls the entire temperature maintenance process. It includes an ON/OFF switch located on the control face, interior light switch, LED temperature indicator in °C or °F, a HI/LO audio/visual temperature alarm, and a door ajar alarm. The control has a set point memory. Upon start up, the unit will warm up to the last temperature set point. A manager's "lock-out" feature is provided to safeguard pre-determined control settings.

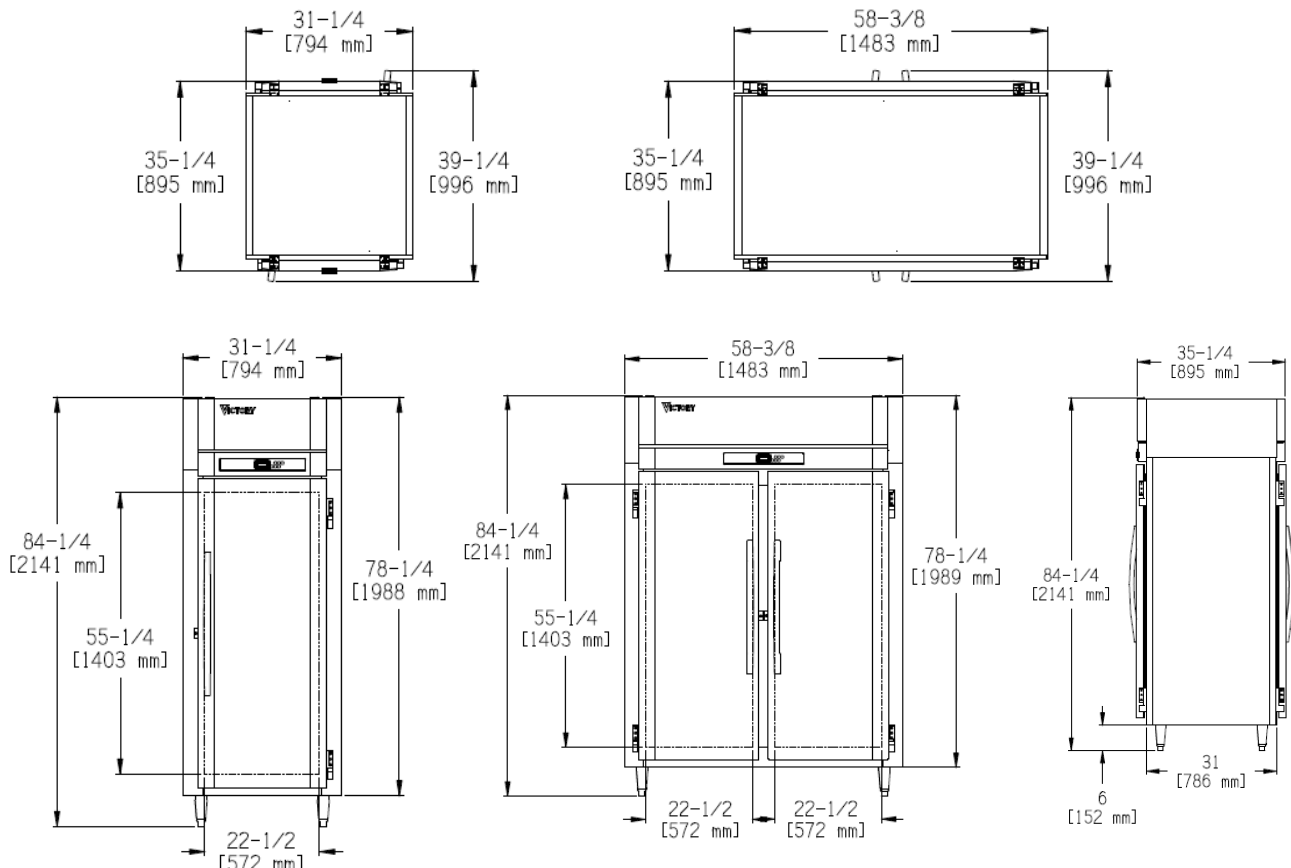
CHARACTERISTICS	1 SECTION	2 SECTION
Width, Overall (in.)	31 1/4"	58 3/8"
Depth, Overall (inc. Handles)	39 1/4"	39 1/4"
Depth, Door(s) Open 90°	85 3/8"	85 3/8"
Height Overall (Inc. 6" legs)	84 1/4"	84 1/4"
Capacity Net (cu ft)	26.2	55.6
No. Full/Half Doors	2 Full, 4 Half	4 Full, 8 Half
No. of Shelves	3	6
Shelf Area (square ft.)	17.6	36.1

### ELECTRICAL DATA

Cabinet Voltage	208-240/60/1	208-240/60/1
Heater Watts per Section (@240V)	1500	1500
Total Wattage (Heaters & Fan @ 240V)	1500	3000
Feed Wires	2	2
NEMA Plug	6-20P	6-20P
Total Amperes	6.3	13

**NOTE:** Plug style, voltage and full load amps may vary depending on certain options selected such as optional voltages and compressor upgrades.

CRATED DIMENSIONS	HEIGHT	WIDTH	DEPTH	FT <sup>3</sup>	LBS
ONE SECTION	83	36	44	76.08	340
TWO SECTION	83	63	44	133.15	590



## EXTRA WIDE PASS-THRU REFRIGERATORS

### Long Door

RS-1D-S1-EW-PT  
RS-2D-S1-EW-PT  
RS-3D-S1-EW-PT

### Half Door

RS-1D-S1-EW-PT-HD  
RS-2D-S1-EW-PT-HD  
RS-3D-S1-EW-PT-HD

RSA-1D-S1-EW-PT  
RSA-2D-S1-EW-PT  
RSA-3D-S1-EW-PT

RSA-1D-S1-EW-PT-HD  
**RSA-2D-S1-EW-PT-HD**  
RSA-3D-S1-EW-PT-HD

- Equipped with Secure-Temp 1.0™ Technology™

- 3 Year Parts & Labor Warranty Plus an Additional 2 Year Compressor Warranty

- Exclusive 2 Year Warranty on Santoprene Door Gaskets

# VICTORY ULTRASPEC™

FEATURING: **SecureTemp**  
1.0

Secure-Temp 1.0™ is the industry's first and only full service temperature monitoring solution for your kitchen. Secure-Temp 1.0™ is standard on all Victory models and is HACCP compliant & meets NAFEM's data protocol.

**There are NO software or monthly monitoring fees.**  
Optional add on kits are available for additional units.

## STANDARD FEATURES

- Secure-Temp 1.0™ Technology
- Full Electronic Control
- LED Lights with Proximity Door Switch Activates Interior Lighting
- Expansion Valve Technology
- 20 Gauge, Stainless Steel Doors
- Dual Speed, Energy Efficient, EC Fan Motors
- Santoprene Door Gaskets with Exclusive 2 Year Warranty
- Stainless Steel Breaker Strips
- High Performance, Balanced, Top-Mounted Refrigeration
- Environmentally Safe, R-134A Refrigerant
- Plasticized Evaporated Fin Coils
- Non-Electric Condensate Evaporator
- Foamed In-Place Polyurethane Insulation
- Heavy-Duty Cylinder Locks
- Self-Closing Doors With 120° Hold Open Feature
- Cam-Lift Hinges
- 6" High Adjustable Stainless Steel Legs
- Hinged Front Shroud Makes Condenser Cleaning Easier
- One Piece, Snap-In Magnetic Door Gasket(s)
- Anti-Condensate Door Perimeter Heaters
- Three (3) Epoxy Coated Wire Shelves Per Cabinet Section
- Cord and Plug (see electrical data for details)



RS-2D-S1-EW-PT

## OPTIONS & ACCESSORIES

- Change Door Swing
- Epoxy Coated, Chrome Plated or Stainless Steel Shelves
- Remote Models: Air Cooled or Water Cooled
- Correctional Facility Options
- UltraSpec Glass Doors
- **6" or 3" Overall Height Casters (set of 4)**
- Exterior Laminate Décor
- Adjustable Tray & Pan Slides
- Optional Voltages
- **FLEXTEMP** Performance Mode



Fuller Middle School  
Framingham, MA

Item #: 42  
Quantity: 2

## CABINET CONSTRUCTION

The cabinet front and doors are constructed of heavy gauge, polished stainless steel to maintain an attractive appearance after years of heavy use. Polyurethane foam insulation throughout ensures the ultimate in energy efficiency. The front shroud lifts up for easy access when cleaning the condenser unit.

## DOOR CONSTRUCTION

The doors are heavy gauge, polished stainless steel with a stainless steel interior liner. Each door is provided with a cylinder lock and ergonomically correct vertical handle. The door hinges are self-closing and have a hold-open feature at 120° which facilitates product loading. Proximity switches energize the recessed interior incandescent lighting when the door is opened. Humidity control wires around the door jamb prevent condensation from forming on the front of the cabinet in high humidity environments. The wires are concealed by a high impact, non-conducting thermal breaker cap.

## REFRIGERATION SYSTEM

All components of the high efficiency, air-cooled, self-contained refrigeration system are mounted on top of the cabinet out of the food storage zone providing greater storage space. Environmentally friendly R-134a refrigerant is efficiently metered by an expansion valve providing a constant, safe operating temperature and quick "recovery" under the most demanding conditions. The hermetically sealed systems are designed to operate at 38°F. Each cooling coil has plasticized fin coils to resist food acids and dual-speed EC fan motor(s) for greater cooling capacity and efficiency. All condensate water is disposed of automatically by the energy efficient, non-electric condensate evaporator.

## INTERIOR STORAGE ARRANGEMENTS

Each cabinet section is provided with three heavy-duty, epoxy coated wire shelves. The shelves are adjustable in one inch increments. A wide door opening allows for the use of a variety of optional pan slide configurations including 18" x 26" and 12" x 20" pans.

## ELECTRONIC CONTROL SYSTEM

The easy to use Electronic Control is standard. This durable, water resistant microprocessor monitors and controls the entire temperature maintenance process. It includes an ON/OFF switch, manual defrost, interior light switch, LED temperature indicator in °C or °F, a HI/LO audio/visual temperature alarm, power supply interruption, door ajar and "clean condenser" alarms. A manager's "lock-out" feature is provided to safeguard predetermined control settings. A HAACP Event Indicator/Memory feature announces and records up to nine (9) alarm events. Unique to the V-TEMP™ are two standard modes of operation:

**SUPERCOOL** - Provides a lower "set-point" refrigeration condition for a set period of time when food has just been loaded into the refrigerator and needs to be quickly brought back down to a safe temperature.

**ENERGY SAVING** - The cabinet automatically reverts to the energy saving mode when there are no door openings for four hours.

A **FLEXTAMP** mode of operation is available as an option. FLEXTAMP provides the ability to select a unique temperature from 28°F to 40°F. This optional feature is ideal for seasonal menu changes and items with specific temperature requirements for dairy, meat, fish or poultry.

CHARACTERISTICS	1 Section	2 Section	3 Section
Net Capacity	26.2	55.6	84.9
Width, Overall (in.)	31 1/4"	58 3/8"	85 1/2"
Depth, Overall (inc. Handles)	39 1/4"	39 1/4"	40 5/8"
Depth, Door(s) Open 90°	85 3/8"	85 3/8"	86 7/8"
Clear Door Width (in.)	22 1/2"	22 1/2"	22 1/2"
Clear Half-Door Height (in.)	25 3/8"	25 3/8"	25 3/8"
Clear Full-Door Height (in.)	55 1/4"	55 1/4"	55 1/4"
Height Overall (inc. 6" legs)	84 1/4"	84 1/4"	84 1/4"
No. Full/Half Doors	2F, 4H	4F, 8H	6F, 12H
No. of Shelves	3	6	9
Shelf Area (sq. ft.)	17.6	36.1	54.3

## ELECTRICAL DATA

Cabinet Voltage	115/60/1	115/60/1	115/60/1
Feed Wires	2	2	2
Condensing Unit Voltage	115/60/1	115/60/1	115/60/1
NEMA Plug	5-15P	5-15P	5-20P
Total Amperes	10	11	13.8

**NOTE:** Plug style, voltage and full load amps may vary depending on certain options selected such as optional voltages and compressor upgrades.

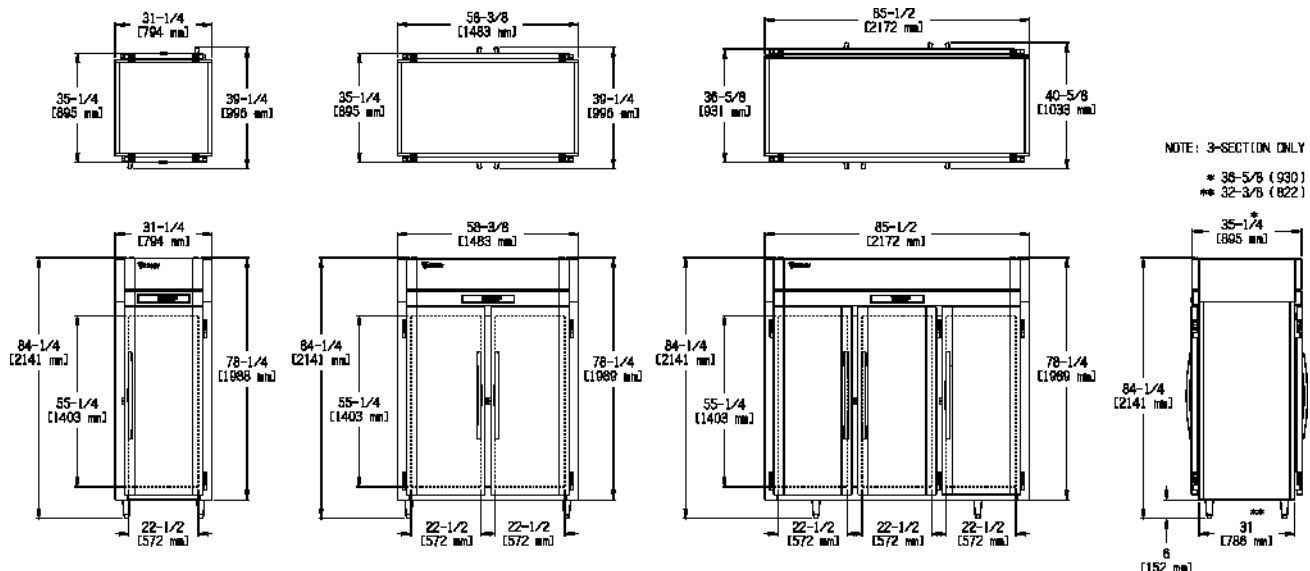
## REFRIGERATION DATA

Condensing Unit Size	1/3 HP	1/3 HP	1/2 HP
Refrigerant	R-134A	R-134A	R-134A

CRATED DIMENSIONS	Height	Width	Depth	Cu. Ft.	Lbs
One Section	83	36"	44	76.08	355
Two Section	83	63	44	133.15	630
Three Section	84	90 3/4	44 3/4	197.41	760

\* Remote units use R-404A refrigerant standard and come with 6" legs

**Note:** In order to provide peak operating performance the cabinet must have a 2 inch all around clearance and 12 inches above the top of the condensing unit. This ensures an adequate air supply and space for routine maintenance and/or service if required.





## EXTRA WIDE REACH-IN WARMING CABINETS

Full Door	Half Door
HS-1D-1-EW-PT HS-2D-1-EW-PT	HS-1D-1-EW-PT-HD HS-2D-1-EW-PT-HD
HSA-1D-1-EW-PT HSA-2D-1-EW-PT	HSA-1D-1-EW-PT-HD <b>HSA-2D-1-EW-PT-HD</b>

- Equipped with Secure-Temp 1.0™ Technology™

- 3 Year Parts & Labor Warranty Plus an Additional 2 Year Compressor Warranty

- Exclusive 2 Year Warranty on Santoprene Door Gaskets

# VICTORY ULTRASPEC™

FEATURING: **SecureTemp**<sub>1.0</sub>

Secure-Temp 1.0™ is the industry's first and only full service temperature monitoring solution for your kitchen. Secure-Temp 1.0™ is standard on all Victory models and is HACCP compliant & meets NAFEM's data protocol.

**There are NO software or monthly monitoring fees.** Optional add on kits are available for additional units.

## STANDARD FEATURES

- Secure-Temp 1.0™ Technology
- Full Electronic Control System
- Adjustable Electronic Temp Control from 80°F to 180°F
- Built-in, Adjustable Humidity Control Vent
- Safety Shielded Strip Type Heating Elements
- Externally Mounted Blower Maintains Even Temperatures
- Foamed-in-Place Polyurethane Insulation
- Heavy Duty Cylinder Locks
- Santoprene Door Gaskets with Exclusive 2 Year Warranty
- Self-Closing Doors with 120° Hold Open Feature
- Cam-Lift Hinges, Guaranteed for Life
- Ergonomically Correct Door Handles, Guaranteed for Life
- 6" High, Adjustable Stainless Steel Legs
- A Series has 6" High Standard Black Legs
- Proximity Door Switch Activates Interior Incandescent Lighting
- One Piece, Snap-In Magnetic Door Gasket(s)
- Stainless Steel Interior Door Liner
- Three (3) Chrome Plated Wire Shelves per Cabinet Section
- 10' Cord & Plug Standard



HS-2D-1-EW-PT-HD

## OPTIONS & ACCESSORIES

- **6"** or 3" Overall Height Casters (Set of 4)
- Exterior Laminate Décor
- Correctional Facilities Options
- Finished Back with Rear Grille
- Stainless Steel Shelves
- Stainless Steel Case Back and Shroud
- 6" Stainless Steel Kick Plate
- Optional Voltages (single section only)

**CABINET CONSTRUCTION**

The cabinet front and doors are constructed of heavy gauge, polished stainless steel to maintain an attractive appearance after years of heavy use. Polyurethane foam insulation throughout ensures the ultimate in energy efficiency.

**DOOR CONSTRUCTION**

The doors are heavy gauge, polished stainless steel with a stainless steel interior liner. Each door is provided with a cylinder lock and ergonomically correct vertical handle. The door hinges are self-closing and have a hold-open feature at 120° which facilitates product loading. Proximity switches energize the recessed interior incandescent lighting when the door is opened.

**HEATING SYSTEM**

The safety shielded, "strip type" heaters located at the bottom of the cabinet interior are precisely controlled by the V-TEMP™ electronic control with a temperature range from 80°F to 180°F. An externally mounted blower system ensures even temperatures throughout the cabinet interior. A built-in, adjustable humidity control vent allows the operator to maintain a moist or more dry environment.

**INTERIOR STORAGE ARRANGEMENTS**

Each cabinet section is provided with three (3) heavy-duty, chrome plated wire shelves. The shelves are adjustable in one inch increments. A wide door opening allows for the use of a variety of optional pan slide configurations including 18" x 26" and 12" x 20" pans.

**ELECTRONIC CONTROL SYSTEM**

The easy to use V-TEMP™ Control is provided standard with a two year parts and labor warranty. This durable, water resistant microprocessor monitors and controls the entire temperature maintenance process. It includes an ON/OFF switch located on the control face, interior light switch, LED temperature indicator in °C or °F, a HI/LO audio/visual temperature alarm, and a door ajar alarm. The control has a set point memory. Upon start up, the unit will warm up to the last temperature set point. A manager's "lock-out" feature is provided to safeguard pre-determined control settings.

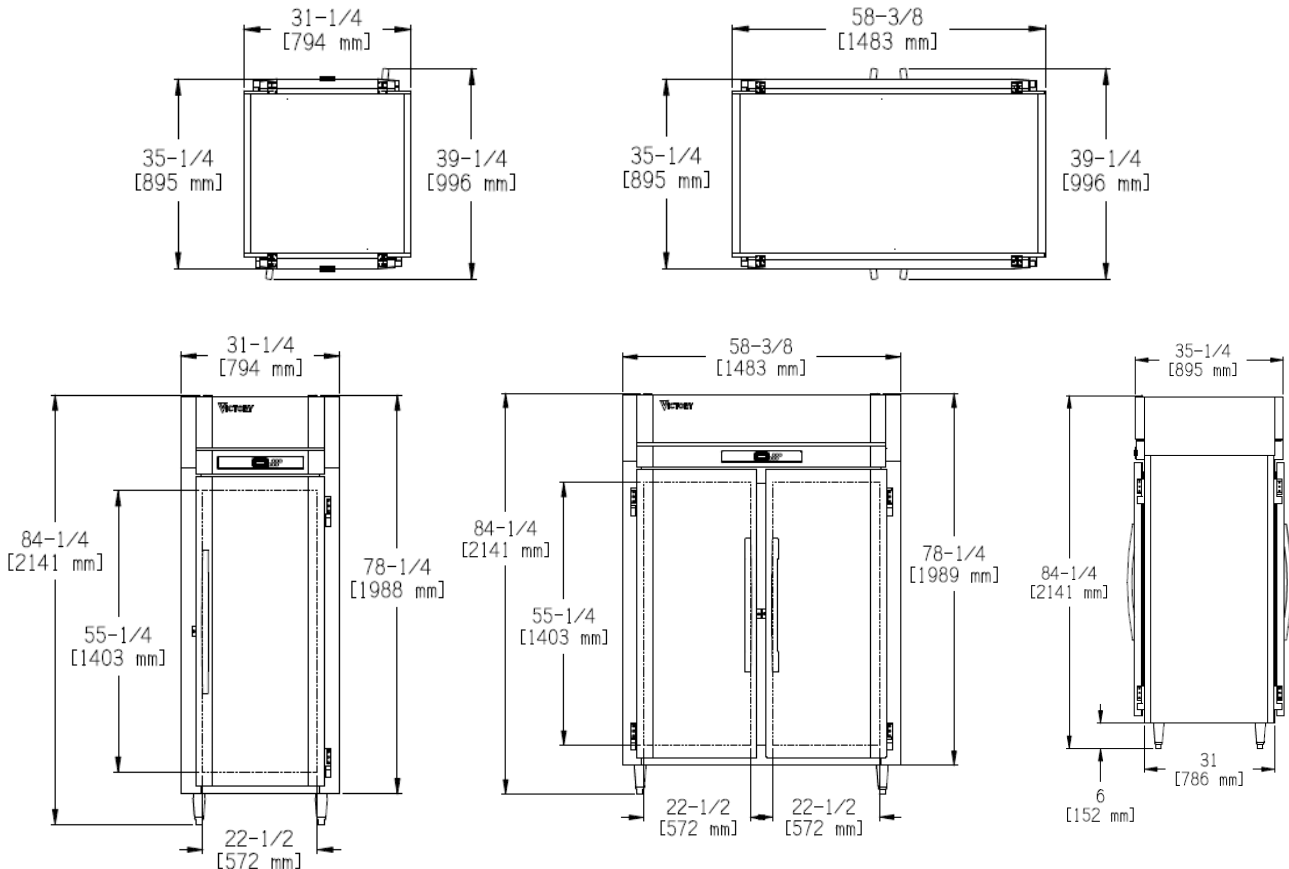
CHARACTERISTICS	1 SECTION	2 SECTION
Width, Overall (in.)	31 1/4"	58 3/8"
Depth, Overall (inc. Handles)	39 1/4"	39 1/4"
Depth, Door(s) Open 90°	85 3/8"	85 3/8"
Height Overall (Inc. 6" legs)	84 1/4"	84 1/4"
Capacity Net (cu ft)	26.2	55.6
No. Full/Half Doors	2 Full, 4 Half	4 Full, 8 Half
No. of Shelves	3	6
Shelf Area (square ft.)	17.6	36.1

**ELECTRICAL DATA**

Cabinet Voltage	208-240/60/1	208-240/60/1
Heater Watts per Section (@240V)	1500	1500
Total Wattage (Heaters & Fan @ 240V)	1500	3000
Feed Wires	2	2
NEMA Plug	6-20P	6-20P
Total Amperes	6.3	13

**NOTE:** Plug style, voltage and full load amps may vary depending on certain options selected such as optional voltages and compressor upgrades.

CRATED DIMENSIONS	HEIGHT	WIDTH	DEPTH	FT <sup>3</sup>	LBS
ONE SECTION	83	36	44	76.08	340
TWO SECTION	83	63	44	133.15	590



Item 44

**CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION:**      **Mobile Work Table**

**Quantity: 1**

**Size: 72"x 30"**

**NO CUT SHEET AVAILABLE**

**CONSTRUCTION FEATURES:**

Make - Fabricate per General Construction this Section

Size - 60" x 30" x 36" high

Construction - 14 gauge stainless steel top over angle frame with edges turned down and mounted on four legs with gussets, 5" diameter swivel casters, two with brakes, and full undershelf and drawer assembly.



Project \_\_\_\_\_

Item # \_\_\_\_\_

Quantity \_\_\_\_\_

## Heated Base Glass Shelves

Portables: HBG-2418, -3018, -3618, -4818, -6018, -7218

Built-Ins: HBGB-2418, -3018, -3618, -4818, -6018, -7218

HBGBH-2418, -3018, -3618, -4818, -6018, -7218

(HBGBH is an international model only)

Hatco Heated Base Glass Shelves have a heated ceramic glass top that creates uniform heat across the entire surface, and are made of approved foodsafe material. Ideal for use on pass-through areas, buffet lines, and as hors d'oeuvre displays.

### Standard features

- Made of approved foodsafe material allowing placement of food product directly on the glass surface
- Thermostatically-controlled ceramic glass surface heated base
- Lighted On/Off rocker switch
- All units are equipped with an attractive trim mounting ring available in stainless steel (standard) *Designer Black* or *White*
- Portable models come with a 1829 mm (6') cord and plug
- Portable models offer an optional angled food stop which keeps product on the heat zone
- Portable models' surface temperature ranges from 100° to 195°F (38° to 90° C)
- Built-In standard and high watt models are recommended for use in metallic counters – for other surfaces, verify that the material is suitable for temperatures
  - Up to 200°F (93°C) for Standard Built-In\*
  - Up to 257°F (125°C) for High Watt Built-In\*
- Built-in standard and high watt models include control box with 3' (915 mm) conduit and 6' (1829 mm) cord and plug

\* Hatco is not responsible for counter damage caused by heat from the warmer.



### Options (available at time of purchase only)

Ceramic Glass Color  
 Black  White

#### Portable models

Angled Food Stop

- Designer Black*  White
- 24" (610 mm)  30" (672 mm)  36" (914 mm)
- 48" (1219 mm)  60" (1524 mm)  72" (1829 mm)

Trim Ring color - Stainless Steel is standard color (Non-standard colors are non-returnable)

- Designer Black*  White

*Frame (base) color* - Stainless Steel is standard color

- Designer Black*  White

#### Built-In models

*Designer Color* for Flush Mount Control Bezel Box - Stainless Steel is standard color (Non-standard colors are non-returnable)

- Designer Black*  White

Unit without Trim Ring (HBGBH models only)

Flush Mount Electronic Control Box with Lighted Power Switch – CE not available (HBGB models only)

Flush Mount Thermostatic Control Box with Lighted Power Switch (HBGB models only)

72" (1829 mm) conduit in lieu of standard 36" (915 mm) used with Flush Mount Electronic Control Box (HBGB models only)

36" (915 mm) conduit in lieu of standard 72" (1829 mm) used with Flush Mount Electronic Control Box (HBGBH models only)

120" (3050 mm) conduit used with Flush Mount Electronic Control Box (in lieu of standard 36" (915 mm) for HBGB and 72" (1829 mm) for HBGBH)

Built-In Heated Base Glass Shelf with Recessed Top (HBGB models only)

**Note for Heated Base Glass Shelves with overhead Strip Heaters:** For any size HBGB, the next larger size GRA or GR2A Strip Heater will fit over the top. For example, a HBGB-3018 will require a GRA-36 or GR2A-36. The GRA will have a tight fit to the frame of the base. The GR2A will have approximately a 4" (102 mm) space.

For operation, location and safety information, please refer to the Installation & Operating Manual.



Specific models as marked



Fuller Middle School  
Framingham, MA

Item #: 47  
Quantity: 2

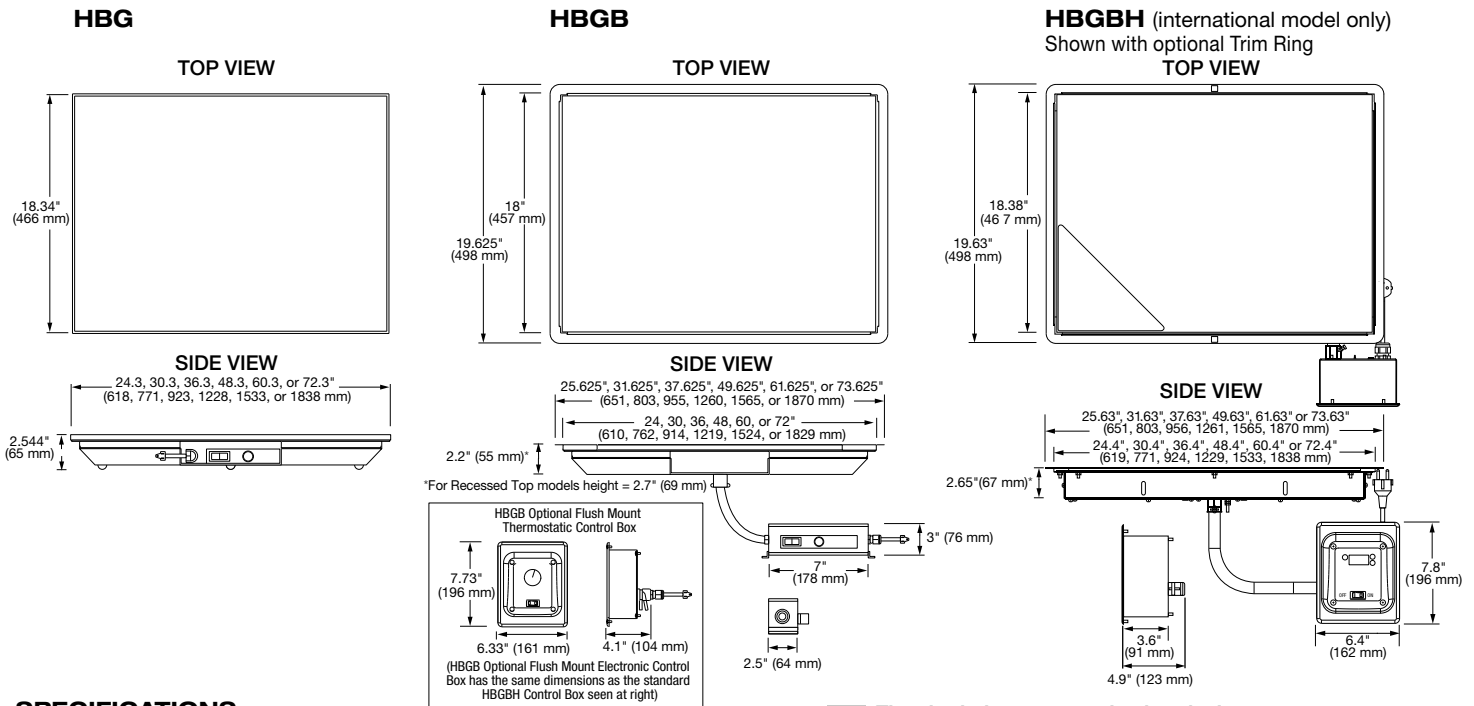


# Heated Base Glass Shelves

Models: HBG-2418, -3018, -3618, -4818, -6018, -7218

HBGB-2418, -3018, -3618, -4818, -6018, -7218

HBGBH-2418, -3018, -3618, -4818, -6018, -7218



## SPECIFICATIONS

### Portable Rectangular Heated Base Glass Shelves

The shaded areas contain electrical information for International models

Model	Dimensions (Width x Depth x Height <sup>▲</sup> )	Voltage	Watts	Amps	Plug	Ship Weight <sup>*</sup>
HBG-2418	24.3" x 18.3" x 2.544" (618 x 466 x 65 mm)	100	425	4.3	NEMA 5-15P	29 lbs. (14 kg)
		120	425	3.5	NEMA 5-15P	
		220 <sup>z</sup>	420	1.9	BS-1363	
		220-230 (CE)	420-459	1.9-2.0	CEE 7/7 Schuko	
		230-240 (CE)	459-500	2.0-2.1	BS-1363 or AS 3112 <sup>■</sup>	
HBG-3018	30.3" x 18.3" x 2.544" (771 x 466 x 65 mm)	100	525	5.3	NEMA 5-15P	33 lbs. (15 kg)
		120	525	4.4	NEMA 5-15P	
		220 <sup>z</sup>	525	2.4	BS-1363	
		220-230 (CE)	525-574	2.4-2.5	CEE 7/7 Schuko	
		230-240 (CE)	574-625	2.5-2.6	BS-1363 or AS 3112 <sup>■</sup>	
HBG-3618*	36.3" x 18.3" x 6.15" (923 x 466 x 156 mm)	100	630	6.3	NEMA 5-15P	36 lbs. (17 kg)
		120	630	5.3	NEMA 5-15P	
		220 <sup>z</sup>	630	2.9	BS-1363	
		220-230 (CE)	630-689	2.9-3.0	CEE 7/7 Schuko	
		230-240 (CE)	689-750	3.0-3.1	BS-1363 or AS 3112 <sup>■</sup>	
HBG-4818* <sup>≈</sup>	48.3" x 18.3" x 6.15" (1228 x 466 x 156 mm)	100	850	8.5	NEMA 5-15P	42 lbs. (19 kg)
		120	850	7.1	NEMA 5-15P	
		220 <sup>z</sup>	840	3.8	BS-1363	
		220-230 (CE)	840-918	3.8-4.0	CEE 7/7 Schuko	
		230-240 (CE)	918-1000	4.0-4.2	BS-1363 or AS 3112 <sup>■</sup>	
HBG-6018* <sup>≈</sup>	60.3" x 18.3" x 6.15" (1533 x 466 x 156 mm)	100	1050	10.5	NEMA 5-15P	60 lbs. (28 kg)
		120	1050	8.8	NEMA 5-15P	
		220 <sup>z</sup>	1050	4.8	BS-1363	
		220-230 (CE)	1050-1148	4.8-5.0	CEE 7/7 Schuko	
		230-240 (CE)	1148-1250	5.0-5.2	BS-1363 or AS 3112 <sup>■</sup>	
HBG-7218* <sup>≈</sup>	72.3" x 18.3" x 6.15" (1838 x 466 x 156 mm)	100	1260	12.6	NEMA 5-15P	68 lbs. (31 kg)
		120	1260	10.5	NEMA 5-15P	
		220 <sup>z</sup>	1260	5.7	BS-1363	
		220-230 (CE)	1260-1378	5.7-6.0	CEE 7/7 Schuko	
		230-240 (CE)	1378-1500	6.0-6.3	BS-1363 or AS 3112 <sup>■</sup>	

▲ For Angled Food Stop option, add 0.5" (13 mm) to the Width, Depth and Height dimensions.

\* Shipping weight includes packaging.

■ AS3112 plug is for use in Australia only.

• Height includes standard 4" legs.

≈ Units 48" (1219 mm) and larger are constructed of two equal size pieces of glass which create a seam.

z 60 Hz



Fuller Middle School  
Framingham, MA

Item #: 47  
Quantity: 2



# Heated Base Glass Shelves

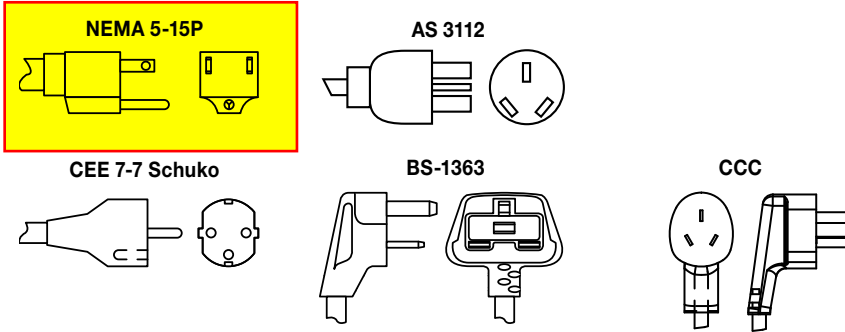
Models: HBG-2418, -3018, -3618, -4818, -6018, -7218  
 HBGB-2418, -3018, -3618, -4818, -6018, -7218  
 HBGBH-2418, -3018, -3618, -4818, -6018, -7218

## CORD LOCATION

HBG: Center of side with switch.  
 HBGB and HBGBH: Cord is attached to Control Box

## PLUG CONFIGURATIONS

Please refer to electrical specifications shown in charts.



## Countertop Cutout Dimensions for Built-Ins

Model	Min. Width	Max. Width	Min. Depth	Max. Depth
HBGB, HBGBH-2418	24.625" (625 mm)	24.875" (632 mm)	18.625" (473 mm)	18.875" (480 mm)
HBGB, HBGBH-3018	30.625" (778 mm)	30.875" (784 mm)	18.625" (473 mm)	18.875" (480 mm)
HBGB, HBGBH-3618	36.625" (930 mm)	36.875" (937 mm)	18.625" (473 mm)	18.875" (480 mm)
HBGB, HBGBH-4818	48.625" (1235 mm)	48.875" (1241 mm)	18.625" (473 mm)	18.875" (480 mm)
<b>HBGB, HBGBH-6018</b>	<b>60.625"</b> <b>(1540 mm)</b>	<b>60.875"</b> <b>(1546 mm)</b>	<b>18.625"</b> <b>(473 mm)</b>	<b>18.875"</b> <b>(480 mm)</b>
HBGB, HBGBH-7218	72.625" (1845 mm)	72.875" (1851 mm)	18.625" (473 mm)	18.875" (480 mm)

## Control Box Cutout Dimensions for Built-Ins

Model	Width	Height	Depth
HBGB standard	7.25" (238 mm)	3.25" (83 mm)	2.75" (70 mm)
HBGB-FLUSH-ITC	5.875" (149 mm)	6.375" (162 mm)	4.75" (121 mm)
HBGB-FLUSH-TSTAT	5.875" (149 mm)	6.375" (162 mm)	4" (102 mm)
HBGBH standard	5.875" (149 mm)	6.375" (162 mm)	4.75" (121 mm)

## PRODUCT SPECS Heated Base Glass Shelves

The Heated Base Glass Shelf shall be a Hatco Model ... as manufactured by the Hatco Corporation, Milwaukee, WI 53234 U.S.A.

The Heated Base Glass Shelf shall be rated at ... watts, volts, and ... inches (millimeters) in overall width. It shall consist of food-safe material, thermostatically-

controlled heated base, and a 6' (1829 mm) cord with plug attached or a remote box with 3' (914 mm) conduit (HBGB models only).

Warranty consists of 24/7 parts and service assistance (U.S. and Canada only). All Glo-Ray® blanket heating elements warranted against burnout for one year (U.S. and Canada only).



Fuller Middle School  
 Framingham, MA

Item #: 47  
 Quantity: 2



There's only one #1™

# Glo-Ray® Aluminum Infrared Strip Heaters

Models: GRA-18, -24, -30, -36, -42, -48, -54, -60, -66, -72, -84, -96, -108, -120, -132, -144  
GRAH-18, -24, -30, -36, -42, -48, -54, -60, -66, -72, -84, -96, -108, -120, -132, -144

Safely hold the temperature of your product without drying out or further cooking food with Hatco's Glo-Ray® Infrared Aluminum Strip Heaters. The end result is hot, fresh food that's ready-to-serve. The continuous aluminum housing and heavy-duty mountings ensure the durability and quality of Hatco products.

## Standard features

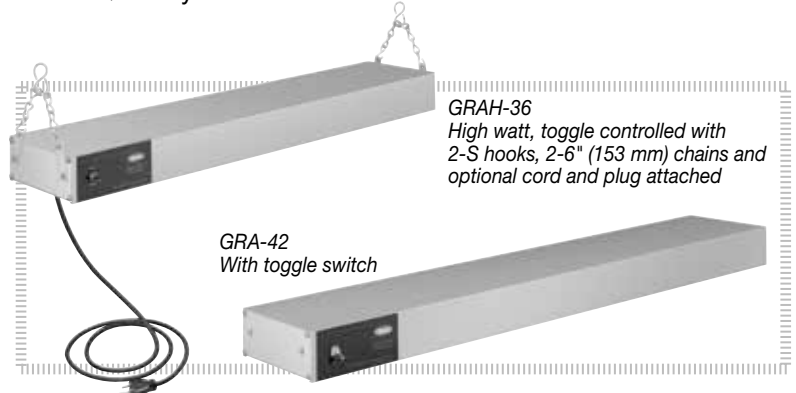
- Prefocused heat pattern covers the entire holding surface
- Consistent holding temperatures with no "cold spots"
- Sturdy extruded aluminum housings that do not sag, in widths from 18" to 144" (457 to 3658 mm)
- Standard and high watt models available
- Reflector does not blacken, maintaining a consistent heat pattern
- Protective wire guards under heating element
- Insulation minimizes heat loss
- Factory assembled with mounting tabs, ready to install quickly and easily
- All units single phase only
- Additional reflector styles and lower wattage elements also available, please consult factory for more information

†Non-standard colors are non-returnable

Project \_\_\_\_\_

Item # \_\_\_\_\_

Quantity \_\_\_\_\_



## Options (available at time of purchase only)

- 6" (152 mm) housing - Designer Color or Gloss Finish<sup>†</sup> (clear anodized standard)
  - Warm Red     Black     Gray Granite     White Granite
  - Navy Blue     Hunter Green     Antique Copper     Radiant Red
  - Glossy Gray     Bold Black     Gleaming Gold     Brilliant Blue
- Indicator Light (not available as Built-In with Tandem Element option)
- Leads - Extended beyond standard 3' (914 mm), conduit on 120V, 208V, 240V models only (must specify lead length)
  - 1'-5" (305-1525 mm)     6'-10" (1829-3048 mm)
  - 11'-15" (3352-4572 mm)     16'-20" (4877-6096 mm)
- Sneeze Guard
  - 9.375" (238 mm) - One side     9.375" (238 mm) - Two sides
  - 14" (356 mm) - One side     14" (356 mm) - Two sides
- No Control
- Infinite Control (remote enclosure recommended), consult factory if element rating exceeds 12.2 amps
  - Built-in (max. of 12.2 amps) (remote installation recommended)
  - Remote Infinite Switch (max. 12.2 amps)
- Remote Control Enclosure - Designer Color or Gloss Finish<sup>†</sup> (clear anodized standard)
  - Warm Red     Black     Gray Granite     White Granite
  - Navy Blue     Hunter Green     Antique Copper     Radiant Red
  - Glossy Gray     Bold Black     Gleaming Gold     Brilliant Blue
- Adjustable Tubular Stands 10"-14" (254-356 mm) - Permanent, for hardwired installation
- Non-Adjustable Tubular Stands (choose clearance and color below)
  - 10" (254 mm)     12" (305 mm)     14" (356 mm)     16" (406 mm)
  - Designer Color or Gloss Finish for Stands<sup>†</sup> (clear anodized standard)
    - Warm Red     Black     Gray Granite     White Granite
    - Navy Blue     Hunter Green     Antique Copper     Radiant Red
    - Glossy Gray     Bold Black     Gleaming Gold     Brilliant Blue
- C-Leg Stands - Portable, for cord & plug installation
  - Standard Watt - 10" (254) clearance - for models up to 72" (1829 mm) wide
  - High Watt - 13.5" (343 mm) clearance - for models up to 72" (1829 mm) wide
- T-Leg Stands - for models up to 72" (1829 mm) wide, specify clearance - Portable, for cord & plug installation
  - 10" (254 mm) (Standard Watt)     13.5" (343 mm)     16" (406 mm)     18" (457 mm)
- Attached 6' (1829 mm) Cord & Plug Set on 120V models up to 72" (1829 mm) wide requires Standard Chain Mount Kit (two S hooks with two 6" (153 mm) lengths of chain), or add optional C-leg stands, or T-leg stands (see specific model for plug configuration)
- Two S hooks with two 6" (153 mm) lengths of chain - Stationary, for cord & plug installation
- Attached 6' (1829 mm) Cord & Plug Set on Export Price List models up to 96" (2438 mm) wide

## Accessories

- Adjustable Angle Brackets (with clearance above unit)
  - 1"-2" (25-51 mm)     7" (178 mm) - GRA models only
- Chain Suspension



Fuller Middle School  
Framingham, MA

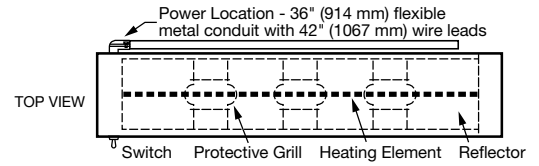
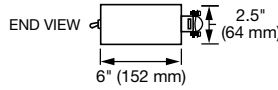
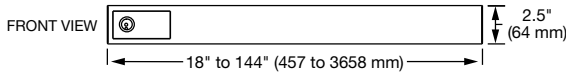
Item #: 48  
Quantity: 2



# Glo-Ray® Aluminum Infrared Strip Heaters

Models: GRA-18, -24, -30, -36, -42, -48, -54, -60, -66, -72, -84, -96, -108, -120, -132, -144  
 GRAH-18, -24, -30, -36, -42, -48, -54, -60, -66, -72, -84, -96, -108, -120, -132, -144

## GRA and GRAH



## SPECIFICATIONS

### Glo-Ray® Aluminum Infrared Strip Heaters

**Phase:** All Single Phase

**Amps:** Amps on all models vary based on configuration – please consult factory.

The shaded areas contain electrical information for International models

Standard Watt			High Watt			Both Models		
Model	Volts	Watt	Model	Volts	Watt	Width x Depth x Height	Plug (Optional)	Ship Weight.*
GRA-18	120	250	GRAH-18	120	350	18" x 6" x 2.5" (457 x 153 x 64 mm)	NEMA 5-15P	7 lbs. (4 kg.)
	208			208			-	
	240			240			-	
	-	-		100	350		-	
	200	231		200	324		-	
	220	250		220	350		CEE 7-7 Schuko BS-1363	
	240			240	350			
	220-230 (CE)*			250-273	220-230 (CE)*		350-383	
230-240 (CE)*	230-250	230-240 (CE)*	321-350					
GRA-24	120	350	GRAH-24	120	500	24" x 6" x 2.5" (610 x 153 x 64 mm)	NEMA 5-15P	8 lbs. (4 kg.)
	208			208			-	
	240			240			-	
	-	-		100	500		-	
	200	324		200	462		-	
	220	350		220	500		CEE 7-7 Schuko BS-1363	
	240			240	500			
	220-230 (CE)*			350-383	220-230 (CE)*		500-547	
230-240 (CE)*	321-350	230-240 (CE)*	459-500					
GRA-30	120	450	GRAH-30	120	660	30" x 6" x 2.5" (762 x 153 x 64 mm)	NEMA 5-15P	9 lbs. (5 kg.)
	208			208			-	
	240			240			-	
	-	-		100	660		-	
	200	416		200	610		-	
	220	450		220	660		CEE 7-7 Schuko BS-1363	
	240			240	660			
	220-230 (CE)*			450-492	220-230 (CE)*		660-721	
230-240 (CE)*	413-450	230-240 (CE)*	606-660					
GRA-36	120	575	GRAH-36	120	800	36" x 6" x 2.5" (914 x 153 x 64 mm)	NEMA 5-15P	9 lbs. (5 kg.)
	208			208			-	
	240			240			-	
	-	-		100	800		-	
	200	532		200	740		-	
	220	575		220	800		CEE 7-7 Schuko BS-1363	
	240			240	800			
	220-230 (CE)*			575-629	220-230 (CE)*		800-875	
230-240 (CE)*	528-575	230-240 (CE)*	735-800					
GRA-42	120	675	GRAH-42	120	950	42" x 6" x 2.5" (1067 x 153 x 64 mm)	NEMA 5-15P	12 lbs. (6 kg.)
	208			208			-	
	240			240			-	
	-	-		100	950		-	
	200	624		200	878		-	
	220	675		220	950		CEE 7-7 Schuko BS-1363	
	240			240	950			
	220-230 (CE)*			675-738	220-230 (CE)*		950-1038	
230-240 (CE)*	620-675	230-240 (CE)*	873-950					
GRA-48	120	800	GRAH-48	120	1100	48" x 6" x 2.5" (1219 x 153 x 64 mm)	NEMA 5-15P	13 lbs. (6 kg.)
	208			208			-	
	240			240			-	
	-	-		100	1100		-	
	200	740		200	1017		-	
	220	800		220	1100		CEE 7-7 Schuko BS-1363	
	240			240	1100			
	220-230 (CE)*			800-874	220-230 (CE)*		1100-1202	
230-240 (CE)*	735-800	230-240 (CE)*	1010-1100					

\* Shipping weight includes packaging and does not include RMB.

\* CE approved units for 220-230V utilize a 220V heating system; 230-240V CE units utilize a 240V heating system.



Fuller Middle School  
 Framingham, MA

Item #: 48  
 Quantity: 2





# Glo-Ray® Aluminum Infrared Strip Heaters

Models: GRA-18, -24, -30, -36, -42, -48, -54, -60, -66, -72, -84, -96, -108, -120, -132, -144  
 GRAH-18, -24, -30, -36, -42, -48, -54, -60, -66, -72, -84, -96, -108, -120, -132, -144

## SPECIFICATIONS

### Glo-Ray® Aluminum Infrared Strip Heaters

Phase: All Single Phase

Amps: Amps on all models vary based on configuration – please consult factory.

The shaded areas contain electrical information for International models

Standard Watt			High Watt			Both Models		
Model	Volts	Watt	Model	Volts	Watt	Width x Depth x Height	Plug (Optional)	Ship Weight.*
GRA-54	120	925	GRAH-54	120	1250	54" x 6" x 2.5" (1372 x 153 x 64 mm)	NEMA 5-15P	14 lbs. (7 kg.)
	208			208			-	
	240			240			-	
	200	855		200	1156		-	
	220	925		220	1250		CEE 7-7	
	240			240	Schuko BS-1363			
	220-230 (CE)*			925-1011	220-230 (CE)*		1250-1366	
	230-240 (CE)*	850-925		230-240 (CE)*	1148-1250			
GRA-60	120	1050	GRAH-60	120	1400	60" x 6" x 2.5" (1524 x 153 x 64 mm)	NEMA 5-15P	16 lbs. (8 kg.)
	208			208			-	
	240			240			-	
	200	971		200	1295		-	
	220	1050		220	1400		CEE 7-7	
	240			240	Schuko BS-1363			
	220-230 (CE)*			1050-1148	220-230 (CE)*		1400-1530	
	230-240 (CE)*	964-1050		230-240 (CE)*	1286-1400			
GRA-66	120	1160	GRAH-66	120	1560	66" x 6" x 2.5" (1676 x 153 x 64 mm)	NEMA 5-15P <sup>▶</sup>	16 lbs. (8 kg.)
	208			208			-	
	240			240			-	
	200	1073		200	1442		-	
	220	1160		220	1560		CEE 7-7	
	240			240	Schuko BS-1363			
	220-230 (CE)*			1160-1268	220-230 (CE)*		1560-1705	
	230-240 (CE)*	1066-1160		230-240 (CE)*	1433-1560			
GRA-72	120	1275	GRAH-72	120	1725	72" x 6" x 2.5" (1829 x 153 x 64 mm)	NEMA 5-15P <sup>▶</sup>	18 lbs. (9 kg.)
	208			208			-	
	240			240			-	
	200	1179		200	1595		-	
	220	1275		220	1725		CEE 7-7	
	240			240	Schuko BS-1363			
	220-230 (CE)*			1275-1394	220-230 (CE)*		1725-1886	
	230-240 (CE)*	1171-1275		230-240 (CE)*	1584-1725			
GRA-84 <sup>‡</sup>	120	1500	GRAH-84 <sup>‡</sup>	120	2050	84" x 6" x 2.5" (2134 x 153 x 64 mm)	-	19 lbs. (9 kg.)
	208			208			-	
	240			240			-	
	200	1387		200	1895		CEE 7-7	
	220	1500		220	2050		Schuko BS-1363	
	240			240				
GRA-96 <sup>‡</sup>	120	1725	GRAH-96 <sup>‡</sup>	120	2400	96" x 6" x 2.5" (2438 x 153 x 64 mm)	-	21 lbs. (10 kg.)
	208			208			-	
	240			240			-	
	200	1595		200	2219		CEE 7-7	
	220	1725		220	2400		Schuko BS-1363	
	240			240				
GRA-108 <sup>‡</sup> ♣	120	1850	GRAH-108 <sup>‡</sup> ♣	120	2500	108" x 6" x 2.5" (2743 x 153 x 64 mm)	-	23 lbs. (11 kg.)
	208			208			-	
	240			240			-	
	200	1710		200	2311			
	220	1850		220	2500			
	240			240				
GRA-120 <sup>‡</sup> ♣	120	2100	GRAH-120 <sup>‡</sup> ♣	120	2800	120" x 6" x 2.5" (3048 x 153 x 64 mm)	-	26 lbs. (12 kg.)
	208			208			-	
	240			240			-	
	200	1942		200	2589			
	220	2100		220	2800			
	240			240				

\* Shipping weight includes packaging and does not include RMB.

♣ CE approved units for 220-230V utilize a 220V heating system; 230-240V CE units utilize a 240V heating system.

• 120V models with infinite switch require tandem (end-to-end) elements, consult factory for applications.

♣ Glo-Ray models 108"-144" (2743-3048 mm) wide and 120V models of GRAH-84 and GRAH-96 contain tandem (end-to-end) elements that may be individually controlled.

‡ Not available with CE Mark.

▶ GRAH-66 and GRAH-72 require NEMA 5-20P cord for Canada.



Fuller Middle School  
 Framingham, MA

Item #: 48  
 Quantity: 2



# Glo-Ray® Aluminum Infrared Strip Heaters

Models: GRA-18, -24, -30, -36, -42, -48, -54, -60, -66, -72, -84, -96, -108, -120, -132, -144  
 GRAH-18, -24, -30, -36, -42, -48, -54, -60, -66, -72, -84, -96, -108, -120, -132, -144

## SPECIFICATIONS

### Glo-Ray® Aluminum Infrared Strip Heaters

Phase: All Single Phase

Amps: Amps on all models vary based on configuration – please consult factory.

The shaded areas contain electrical information for International models

Standard Watt			High Watt			Both Models		
Model	Volts	Watt	Model	Volts	Watt	Width x Depth x Height	Plug (Optional)	Ship Weight.*
GRA-132†♣	120	2320	GRAH-132†♣	120	3120	132" x 6" x 2.5" (3353 x 153 x 64 mm)	-	30 lbs. (14 kg.)
	208			208				
	240			240				
	200			200				
	220			220				
	240			240				
GRA-144†♣	120	2550	GRAH-144†♣	120	3450	144" x 6" x 2.5" (3658 x 153 x 64 mm)	-	33 lbs. (15 kg.)
	208			208				
	240			240				
	200			200				
	220			220				
	240			240				

\* Shipping weight includes packaging and does not include RMB.

♣ Glo-Ray models 108"-144" (2743-3048 mm) wide and 120V models of GRAH-84 and GRAH-96 contain tandem (end-to-end) elements that may be individually controlled.

† Not available with CE Mark.

## TOGGLE SWITCH

Toggle Switch: Max. 15 amps. Location: Chef's left side standard, other options available.

## INFINITE SWITCH

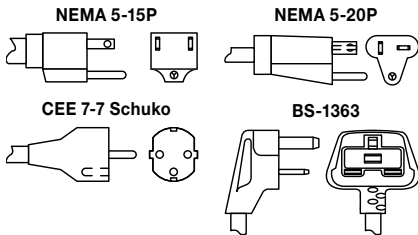
Max. 12.2 amps

## LEADS

36" (914 mm) flexible metal conduit with 42" (1067) wire leads.  
 USA/Canada: 3" (914 mm) conduit with leads – server's right.  
 Export/Euro: 6" (152 mm) leads – server's right.

## PLUG CONFIGURATIONS

Please refer to electrical specification chart.



## RECOMMENDED MOUNTING HEIGHTS

(Refer to the Installation section of the Manual on the Hatco website)

Standard Watt: 8"-11" (203-279 mm) High Watt: 11"-14" (279-356 mm)

## MINIMUM CLEARANCES

### Combustibles

Below overshelf: 1" (25 mm) clearance.  
 Unit to surface below: High watt, 13.5" (343 mm) or Standard watt - 10" (254 mm).  
 Unit to wall: 3" (76 mm).

### Non-Combustibles

#### Hardwired with Built-In Switches:

Must be installed in a pass through area.  
 Below overshelf: 1" (25 mm) clearance.  
 Unit to surface below:  
 High watt with infinite control or indicator light - 10" (254 mm).  
 High watt with On/Off toggle switch - 8" (203 mm).

#### Corded Units with Built-In Switches:

Must be installed in a pass through area.  
 Below overshelf: 3" (76 mm) clearance.  
 Unit to surface below: High watt: 11" (279 mm) or Standard watt: 10" (254 mm).

#### Hardwired Units with Remote Switches:

May be installed against a non-combustible back wall and flush to an overshelf.  
 Unit to surface below: 8" (203 mm).  
 Setback from the front of an overshelf: Maximum 10" (254 mm).

## REMOTE CONTROL ENCLOSURES

RMB series uses one Control Box per Strip Heater - If RMB2 series is used, multiple warmers can be controlled from one box (U.S., Canada only). CE models require any remote switches be contained in a Remote Control Enclosure. For more details, see "Choose Remote Box" section listed under "Resources" on the Hatco website, or consult Price List.

Model	Width	Maximum Infinite/Toggle Switches	
		U.S., Canada, Export U.S. Dollar	Euro
RMB-3	6" (150 mm)	1 infinite or 2 toggle	1 infinite or 2 toggle
RMB-7	9.375" (239 mm)	2 infinite or 4 toggle	2 infinite or 3 toggle
RMB-14	14.375" (366 mm)	4 infinite or 6 toggle	4 infinite or 4 toggle
RMB-16	16.375" (417 mm)	4 infinite with 1 toggle	-
RMB-20	20.375" (518 mm)	4 infinite with 3 toggle	-
RMB2-1R	11" (279 mm)	1 toggle, 1 infinite, 1 relay, 1 indicator light	-
RMB2-2R	14" (356 mm)	1 toggle, 1 infinite, 2 relays, 1 indicator light	-

## PRODUCT SPECS

### Infrared Foodwarmer

The Infrared Foodwarmer shall be a Glo-Ray®, manufactured by the Hatco Corporation, Milwaukee, WI 53234 U.S.A.

The Strip Heater shall be a Glo-Ray model ..., rated at ... watts, ... volts, single phase and be ... inches (millimeters) in overall width. The Glo-Ray shall consist of an aluminum housing and include as standard equipment four stainless steel shelf mounting tabs and an on-off switch may be optionally installed remotely or to either

the front or rear of the unit. The infrared heating element shall be tubular metal sheathed. The foodwarmer shall be factory assembled ready for electrical installation. Options and accessories shall include adjustable or non-adjustable tubular stand, C-leg stand, T-leg stand, angle brackets, suspension chain and fittings, sneeze guard, cord and plug set, indicator light, and infinite control – remote or built-in.  
 24/7 parts and service assistance (U.S. and Canada only)



Fuller Middle School  
 Framingham, MA

Item #: 48  
 Quantity: 2



# BEVERAGE-AIR

3779 Champion Blvd., Winston-Salem, NC 27105  
1-888-845-9800 Fax# 1-336-245-6453  
<http://www.Beverage-Air.com>

Item No. \_\_\_\_\_  
Quantity \_\_\_\_\_

## SCHOOL MILK COOLERS DUAL ACCESS, FORCED-AIR STF SERIES

MODELS:  
STF49  
STF58

### Commercial Refrigeration Equipment General Specification

#### 3 Year Parts/Labor Warranty Additional 2 Year Compressor Warranty

##### STF SERIES—DUAL ACCESS, FORCED-AIR

Dual-access, Twin top, forced-air milk coolers are designed to hold milk between 36°F to 38°F until ready to serve. Produced in two sizes to hold 12 and 16 milk cases (13" x 13" x 11") per unit. Units will also accommodate (19" x 13" x 11") milk cases.

##### CABINET CONSTRUCTION

Standard construction includes the lid, door, adjustable hinges, and door latches made from stainless steel. Balance of exterior is white finish on steel. One-piece, reinforced stainless steel floor for maximum milk crate support. Balance of interior is galvanized steel. Heavy-duty, epoxy coated steel wire floor racks are provided for added floor protection. Floor drain is centrally located for easy cleaning, connecting to drain hose with hose adapter.

Doors are fitted with flexible compression gaskets to ensure tight seal. All steel construction with 3-screw hinges add to model durability. Self-latching doors provide added convenience with safety bumpers standard.

Digital exterior thermometer, cylinder lock, bottom drain, latch safety bumpers and swivel casters (2 with locks) are provided as standard.

Foamed-in-place CFC and HCFC-free polyurethane insulation enhances the structural strength of the cabinet and helps increase energy efficiency. This insulation helps to prevent liquid penetration that results in foul odors. Overall depth of 33 1/2" allows easy mobility and clear passage through most doorways.

Models are also offered with stainless steel exterior in place of white finish on steel. A stainless steel interior is optionally available. Additional options include wrap around and corner bumpers.

##### REFRIGERATION

Refrigeration system uses R134a refrigerant, which is CFC and HCFC-free for compliance with environmental safety concerns. Dual evaporator evens airflow throughout coolers, completely enveloping contents in a blanket of cold air.

##### ELECTRICAL

Units wired at factory and ready for connection to a 115/60/1 phase, 15 amp dedicated outlet. 8' long cord and plug set included.

##### SPECIAL FEATURES

- One-piece, reinforced stainless steel floor for maximum support of milk crates.
- Stainless options available.



STF49 (white exterior shown)



STF58 (stainless exterior shown)

##### ELECTRICAL CONNECTION



115/60/1  
NEMA-5-15P

Units pre-wired at factory and include 8' long cord and plug set.



Available From:



Fuller Middle School  
Framingham, MA

Item #: 50  
Quantity: 1

Model Specified \_\_\_\_\_

Store# \_\_\_\_\_

Location \_\_\_\_\_

Quantity \_\_\_\_\_



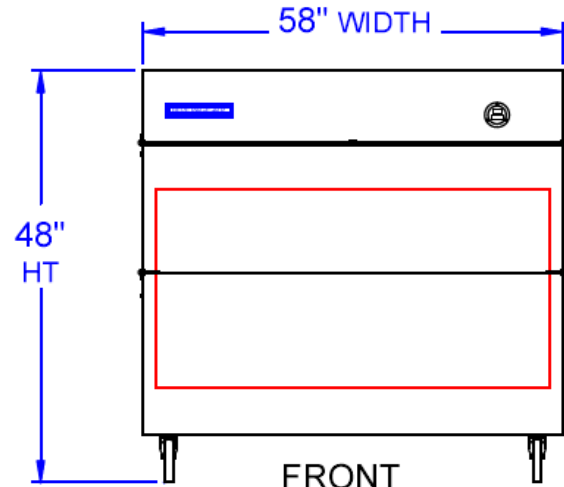
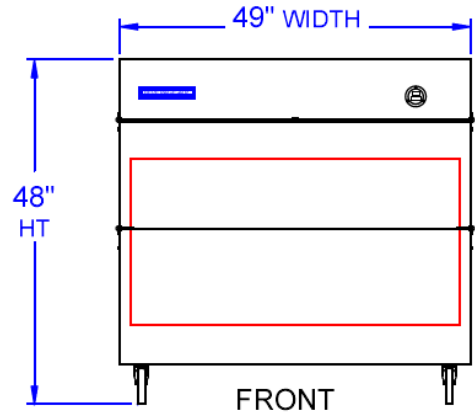
**BEVERAGE-AIR**

**PLAN VIEWS**

**STF SERIES School Milk Coolers**

Models: STF49, STF58

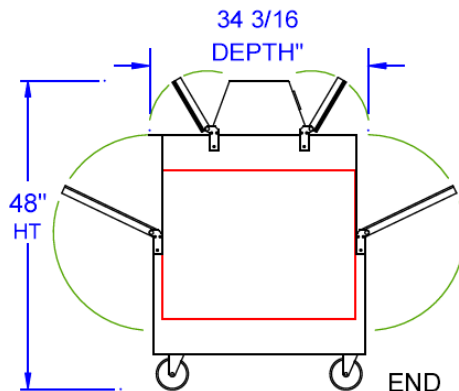
MODEL	STF49	STF58
<b>EXTERNAL DIMENSIONAL DATA</b>		
Length Overall (inches)	49"	58"
Length Overall (mm)	1245	1473
Depth Overall (inches)	34 3/16"	34 3/16"
Depth Overall (mm)	868	868
Height Overall— (inches)	48"	48"
Height Overall—(mm)	1219	1219
Number of doors/lids	4	4
<b>INTERNAL DIMENSIONAL DATA</b>		
NET Capacity (cubic ft.)	20.5	24.5
NET Capacity (Liters)	581	694
<b>CASE CAPACITIES</b>		
13" x 13" x 11"	12	16
19" x 13" x 11"	8	10
<b>ELECTRICAL DATA</b>		
Full Load Amperes 115/60/1	10.1	10.1
<b>ENERGY CONSUMPTION (KWH)</b>		
	8.35	5.65
<b>REFRIGERATION DATA</b>		
Horsepower	1/2	1/2
<b>WEIGHT DATA</b>		
Gross Weight (Crated lbs)	315	463
Gross Weight (Crated kg)	143	210



\*Note: Not all markings may apply to all model variations.

**ELECTRICAL CONNECTION**

Units pre-wired at factory and include 8' long cord and plug set.



**Fuller Middle School**  
Framingham, MA

Item #: 50  
Quantity: 1

**ITEM 51**

**CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION: Mobile Cashier Stand**

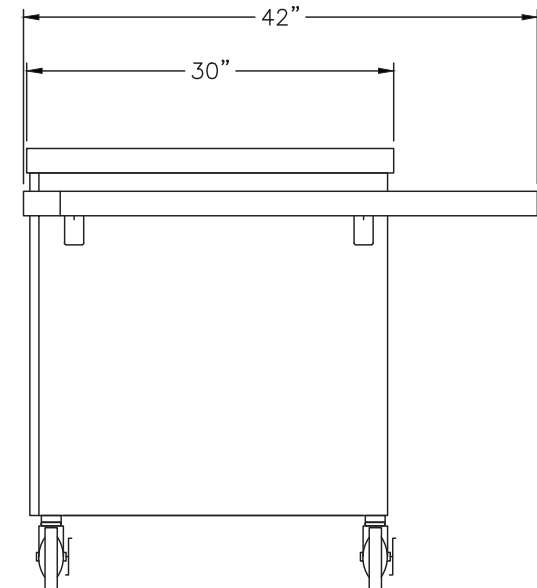
**NO CUT SHEET AVAILABLE**

**CONSTRUCTION FEATURES:**

Make - Fabricate per General Construction this Section

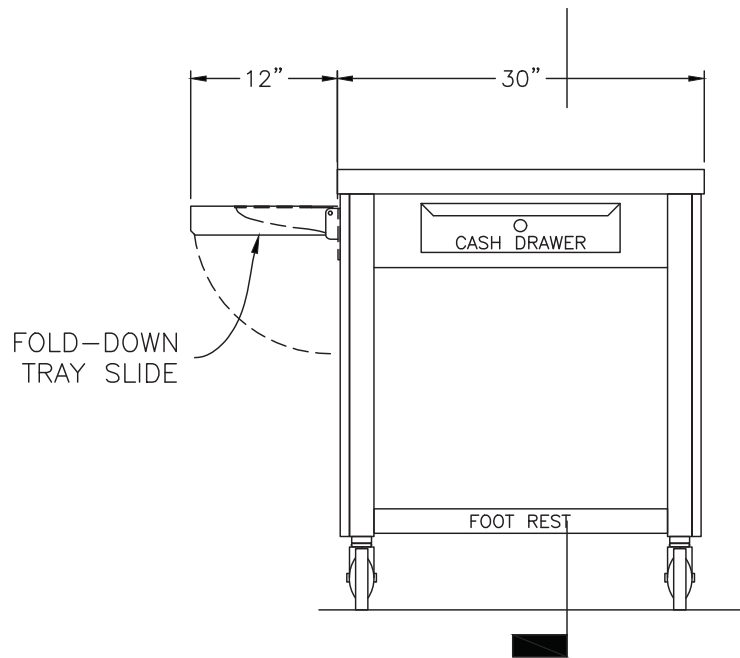
Size - 54" x 27" x 34" high

Construction - 14 gauge stainless steel top over angle frame with all edges turned down 2" and corners welded. Mount on four legs with crossrails on three sides, footrest set in 8", undershelf and plastic laminate clad panels on three sides. Provide 5" diameter swivel casters; two with brakes.



SIDE ELEVATION VIEW

SCALE 1"=1'-0"



CASHIER ELEVATION VIEW

SCALE 1"=1'-0"

**ITEM 52**

**RELATED EQUIPMENT PROVIDED BY OTHERS**

**DESCRIPTION: POS Terminals**

**PROVIDED BY:**

- Owner
- Vendor
- Caterer
- General Contractor
- Plumbing Contractor
- Electrical Contractor
- Ventilation Contractor

**INSTALLED BY:**

- Owner
- Vendor
- Caterer
- General Contractor
- Plumbing Contractor
- Electrical Contractor
- Ventilation Contractor
- Kitchen Equipment Contractor

**ITEM 53**

**CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION: Mobile Cashier Stand**

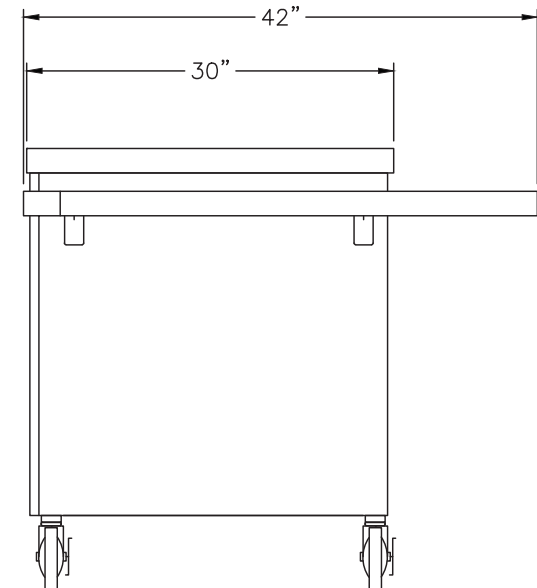
**NO CUT SHEET AVAILABLE**

**CONSTRUCTION FEATURES:**

Make - Fabricate per General Construction this Section

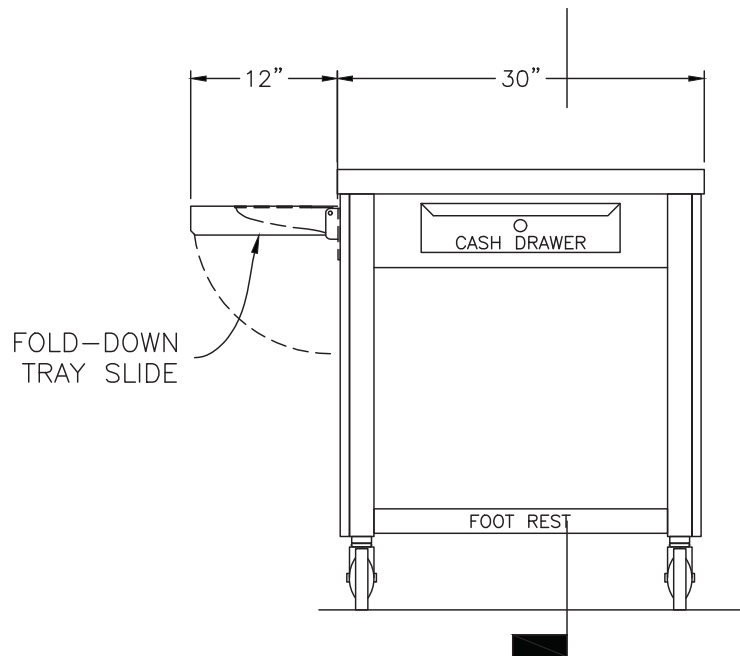
Size - 54" x 27" x 34" high

Construction - 14 gauge stainless steel top over angle frame with all edges turned down 2" and corners welded. Mount on four legs with crossrails on three sides, footrest set in 8", undershelf and plastic laminate clad panels on three sides. Provide 5" diameter swivel casters; two with brakes.



SIDE ELEVATION VIEW

SCALE 1"=1'-0"



CASHIER ELEVATION VIEW

SCALE 1"=1'-0"

**ITEM 55**

**CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION: Mobile Condiment Counter**

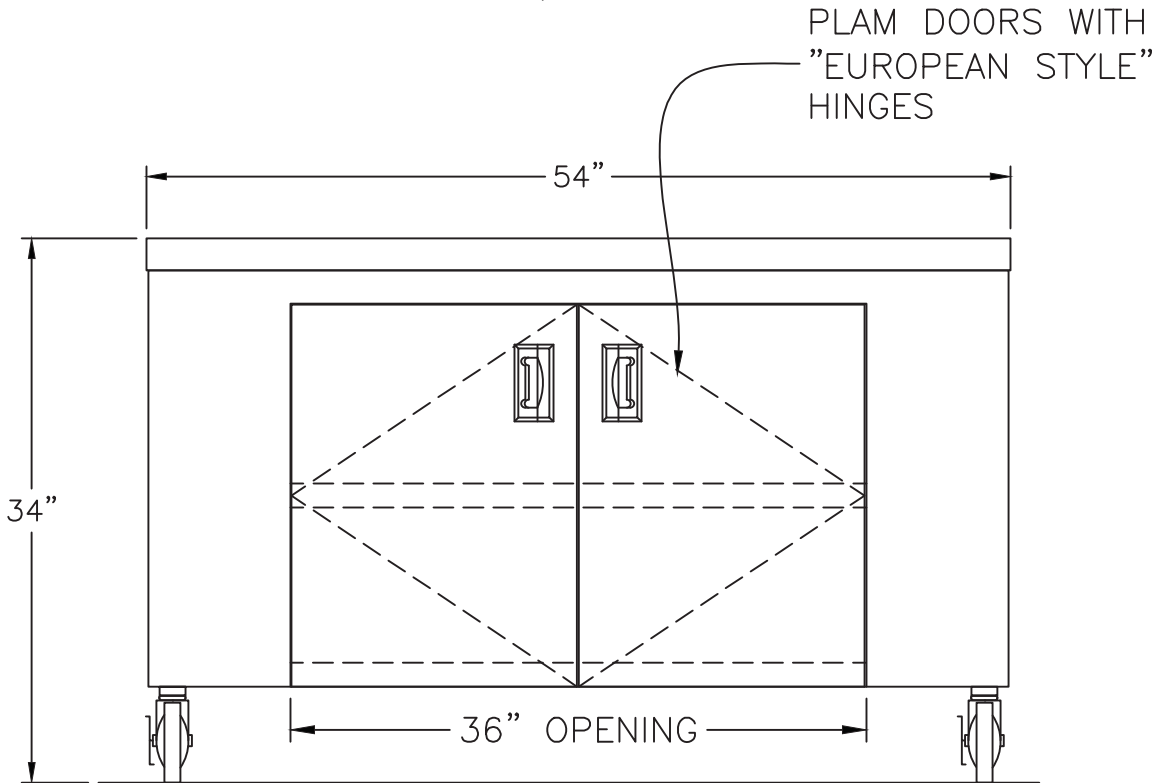
**NO CUT SHEET AVAILABLE**

**CONSTRUCTION FEATURES:**

Make - Fabricate per General Construction this Section

Size - 72" x 27" x 34" high

Construction - 14 gauge stainless steel top over angle frame with all edges turned down 2" and corners welded. Mount on four legs with crossrails, undershelf and plastic laminate clad panels on three sides. Provide 5" diameter swivel casters; two with brakes.



FRONT ELEVATION VIEW

SCALE 1"=1'-0"

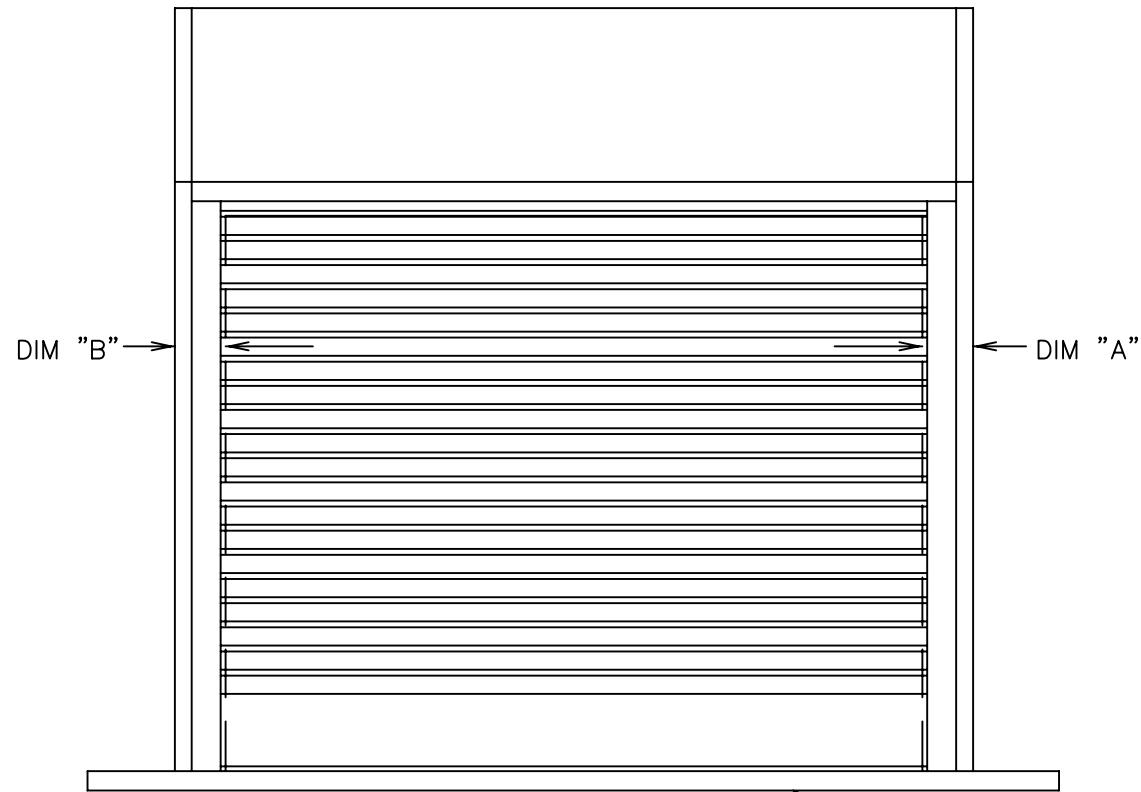


DOOR NUMBER	QTY	OPENING		MODEL	GA.	"A"	"B"	"C"	"D"	"E"	"F"	"G"	"H"	"J"	MOUNT TYPE	OPER.	DRIVE	JAMB TYPE	GUIDE	JOB:		
		WIDTH	HEIGHT																			
																					DISTRIBUTOR:	
																						CONTRACTOR:
																						ARCHITECT:
																						NR:2901843



# DURASHUTTER

DURASHUTTER CA  
INTERIOR FACE MOUNT  
MANUAL LIFT.



"ELEVATION"

COUNTER TOP  
BY OTHERS

LEFT HAND DRIVE  
(SHOWN)

RIGHT HAND DRIVE

DOORS SHALL BE ROLLING STEEL MODEL DURACURTAIN "SELECT" (COUNTER SHUTTER) AS MANUFACTURED BY RAYNOR GARAGE DOORS.

BARREL- STRUCTURAL STEEL PIPE, MINIMUM 4-1/2"(114.3mm) O.D. X 120" (3.0mm) WALL THICKNESS AND DESIGNED TO LIMIT MAXIMUM DEFLECTION, UNDER LOAD, TO .03"(0.76mm) PER FOOT OF SPAN.

SPRING COUNTERBALANCE- THE CURTAIN SHALL BE COUNTERBALANCED BY MEANS OF OIL TEMPERED, HELICAL TORSION SPRINGS, GREASE-PACKED AND MOUNTED ON A SINGLE CONTINUOUS STEEL TORSION SHAFT. SPRINGS SHALL BE COMPRESSION SPRING DESIGN TO FACILITATE ANY COUNTERBALANCE MAINTENANCE. CAST IRON SPRING ANCHORS SHALL TRANSFER FULL SPRING LOADING TO THE BARREL.

BRACKETS- 10 GAUGE GALVANIZED STEEL WITH FLANGED MOUNTING SURFACE FOR HOOD ATTACHMENT. INSIDE SURFACE SHALL BE FLUSH WITH GUIDE GROOVE. DRIVE SIDE BRACKET SHALL BE FITTED WITH A SEALED BALL BEARING FOR CONTINUED PERFORMANCE.

**MODEL CA**

CURTAIN- SHALL BE INTERLOCKING, FLAT FACED, EXTRUDED ALUMINUM (6063-T5) SLATS .05"(1.3mm) THICK. BOTTOM OF CURTAIN TO BE EXTRUDED ALUMINUM (6063-T5) HAVING A HOLLOW RECTANGULAR CROSS SECTION WITH A VINYL ASTRAGAL.

GUIDES- SHALL BE EXTRUDED ALUMINUM (6063-T5) WITH WOOL FIBRE INSERTS ON BOTH SIDES, AND WITH REMOVABLE BELLMOUTH CURTAIN STOPS.

HOOD & SIDE COVER- SHALL BE .04"(1.0mm) THICK ALUMINUM. HOOD TO HAVE ROLLED EDGES TO PROVIDE RIGIDITY.

FINISH - GUIDES, SLATS, BOTTOM BAR, SIDE COVERS AND HOOD TO BE CLEAR ANODIZED 204-R1 FINISH.

- LOCKING- SLIDE BOLT TO ENGAGE GUIDE WITH PROVISION FOR PADLOCK. (PADLOCK BY OTHERS) QUANTITY REQUIRED
- LOCKING- FIVE PIN TUMBLER CYLINDER WITH LOCK BARS TO ENGAGE THE GUIDE. QUANTITY REQUIRED
- LOCK-OPERABLE FROM INTERIOR ONLY.
- LOCK-OPERABLE FROM EXTERIOR ONLY.
- LOCK-OPERABLE FROM BOTH INTERIOR AND EXTERIOR

**DOORS OVER 10'-0" (3048MM) X 7'-0" (2133.6MM) ARE STRONGLY RECOMMENDED TO BE CRANK OR TUBE MOTOR OPERATED.**

SHEET



Fuller Middle School  
Framingham, MA

Item #: 57  
Quantity: 1



**T&S BRASS AND BRONZE WORKS, INC.**  
 2 Saddleback Cove / P.O. Box 1088  
 Travelers Rest, SC 29690

Model No.  
**B-1457-7102-01C**

Item No.

Travelers Rest, SC: 800-476-4103 • Simi Valley, CA: 800-423-0150 • Fax: 864-834-3518 • www.tsbrass.com

This Space for Architect/Engineer Approval

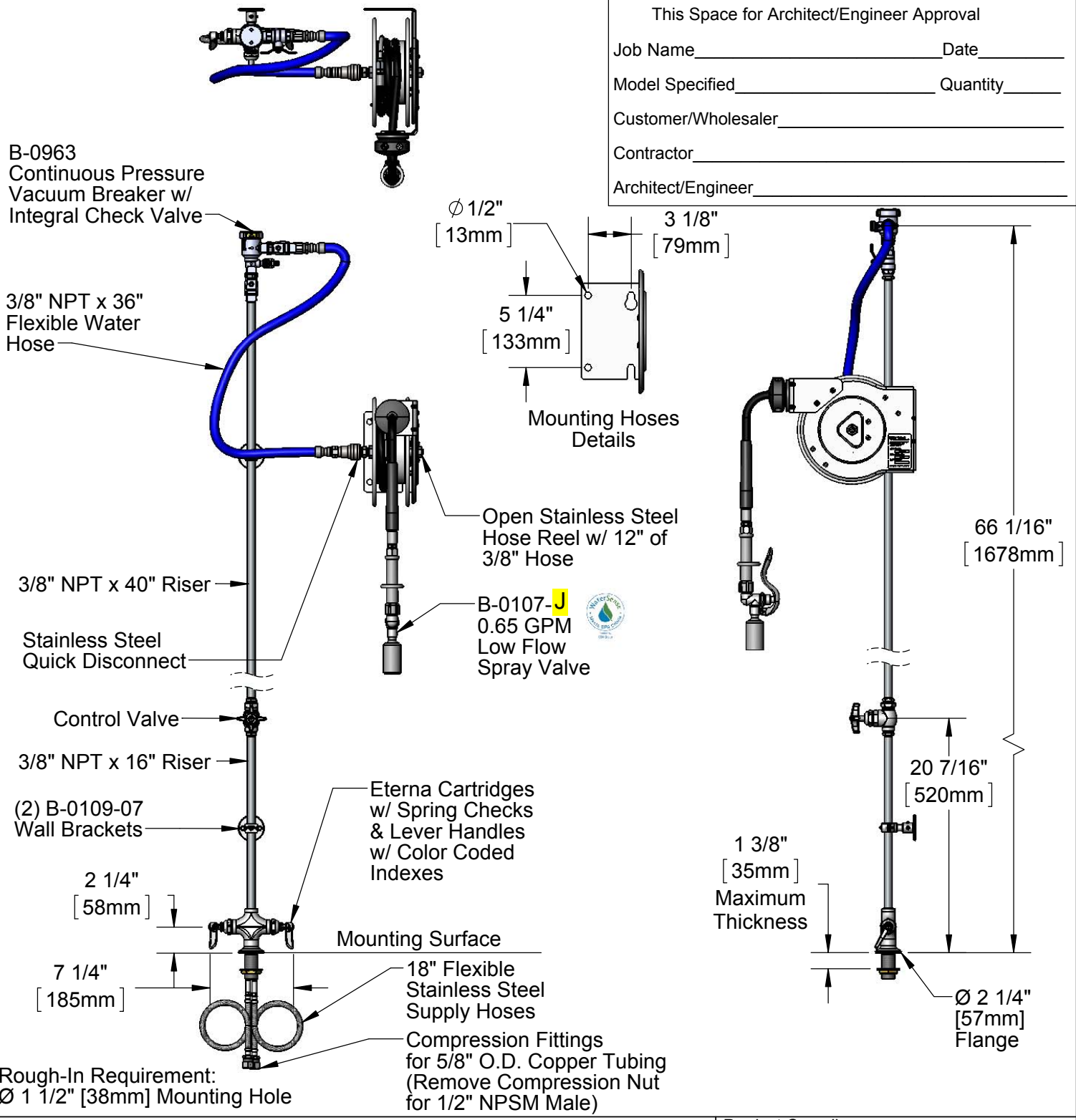
Job Name \_\_\_\_\_ Date \_\_\_\_\_

Model Specified \_\_\_\_\_ Quantity \_\_\_\_\_

Customer/Wholesaler \_\_\_\_\_

Contractor \_\_\_\_\_

Architect/Engineer \_\_\_\_\_



Product Specifications:  
 Open Stainless Steel Hose Reel w/ 12' of 3/8" Hose, Single Hole Dual Temperature Deck Mount Faucet w/ Spring Checks, 0.65 GPM Low

Product Compliance:  
 NSF 61 Exempt (Non-Potable)  
 EPA Act 2005 (PRSV)

	<p><b>Fuller Middle School</b>          Framingham, MA</p>	<p>Item #: 58          Quantity: 1</p>
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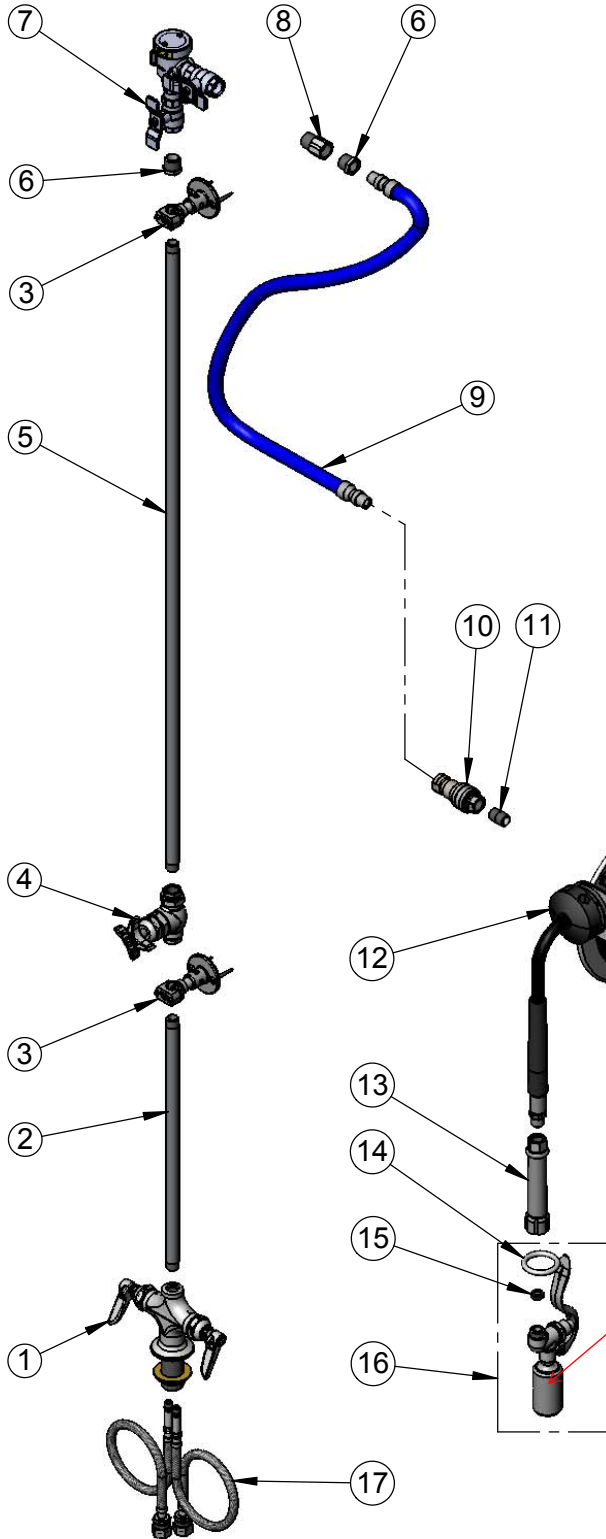


**T&S BRASS AND BRONZE WORKS, INC.**  
 2 Saddleback Cove / P.O. Box 1088  
 Travelers Rest, SC 29690

Model No.  
**B-1457-7102-01C**

Item No.

Travelers Rest, SC: 800-476-4103 • Simi Valley, CA: 800-423-0150 • Fax: 864-834-3518 • www.tsbrass.com



ITEM NO.	SALES NO.	DESCRIPTION
1	002824-40	Single Hole Dual Temp Mixing Faucet w/ Supply Hoses
2	000368-40	3/8" NPT x 16" Riser
3	B-0109-07	Wall Bracket
4	0RK3	Control Valve
5	002558-40	3/8" NPT x 40" Riser
6	001359-40	1/2" NPT Male x 3/8" NPT Female Hex Bushing
7	B-0963	1/2" NPT Continuous Pressure VB w/ Integral Check Valve
8	015073-40	Check Valve 1/2" NPT Adapter
9	HW-2B-36	3/8" NPT x 36" Flexible Water Hose
10	AW-5B	3/8" NPT Quick Disconnect
11	002535-25	3/8" Close Nipple
12	B-7102	Open Stainless Steel Hose Reel w/ 12' x 3/8" Hose
13	002881-40	Grip Handle
14	000907-45	Spray Valve Hold Down Ring
15	010476-45	#27 Washer
16	B-0107-C	0.65 GPM Low Flow Spray Valve
17	012534-45	18" Flexible Supply Hose (2)

**B-107-J water saver**

**Product Specifications:**

Open Stainless Steel Hose Reel w/ 12' of 3/8" Hose, Single Hole Dual Temperature Deck Mount Faucet w/ Spring Checks, 0.65 GPM Low

**Product Compliance:**

NSF 61 Exempt (Non-Potable)  
 EPAAct 2005 (PRSV)



**Fuller Middle School**  
 Framingham, MA

Item #: 58  
 Quantity: 1

**HOBART**701 S Ridge Avenue, Troy, OH 45374  
1-888-4HOBART • www.hobartcorp.com**CL44e  
DISHWASHER****HOBART****STANDARD FEATURES**

- 202 racks per hour
- Opti-RinSe™ system
- Rapid Return Conveyor Drive Mechanism
- Insulated hinged double doors with door interlock switches
- 19.5 inch chamber height opening
- Top mounted micro-processor control module
- Energy saver mode
- Dirty water indicator
- Low temperature alert
- Conveyor dwell
- Delime notification
- Service diagnostics
- NAFEM Data Protocol compliant
- Computational Fluid Dynamic Designed Self-Aligning Wash Manifolds
- Stainless steel debossed anti-clogging wash arms
- Removable Integrated Pump Intake Screen
- Stainless steel self-draining pump and impeller
- Single, sloping scrap screen and deep basket
- Stainless panels enclose perimeter and bottom
- Door actuated drain closure
- Single point electrical connection (three phase only), does not include the booster heater
- Convertible hot water or low temp final rinse
- Vent fan and booster heater control

**DIRECTION OF OPERATION**

- Right to Left
- Left to Right

**VOLTAGE**

- 208/60/1     240/60/1     380/60/3
- 208/60/3     240/60/3     480/60/3
- 600/60/3

**MODEL**

- CL44e – Dishwasher

**OPTIONS AT EXTRA COST**

- Stainless steel pressure-less 15/30 KW booster heater
- Higher than standard chamber

**ACCESSORIES**

- Stainless steel vent hoods
- Direct drive unloader
- Side loader
- Blower-dryer
- Drain water tempering kit
- Flanged feet kit (requires two kits)

Specifications, Details and Dimensions on Inside and Back.

**CL44e DISHWASHER**

# CL44e DISHWASHER

# HOBART

701 S Ridge Avenue, Troy, OH 45374  
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## THE CL<sub>e</sub> WAREWASHER IS NOW STANDARD WITH MORE EFFICIENT FEATURES THAN EVER . . .

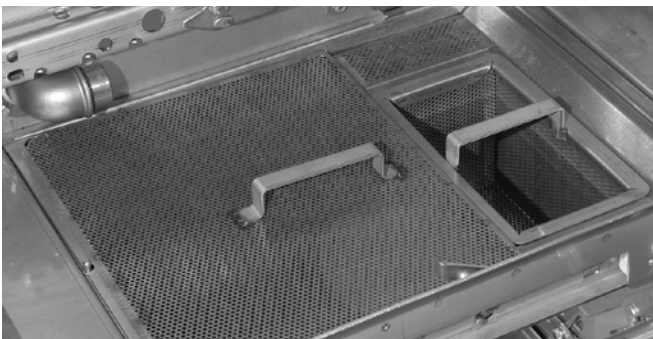
Inside and out the CL<sub>e</sub> warewashers by Hobart are packed with standard components and patented design innovations that make them the biggest value in the dishwasher industry.



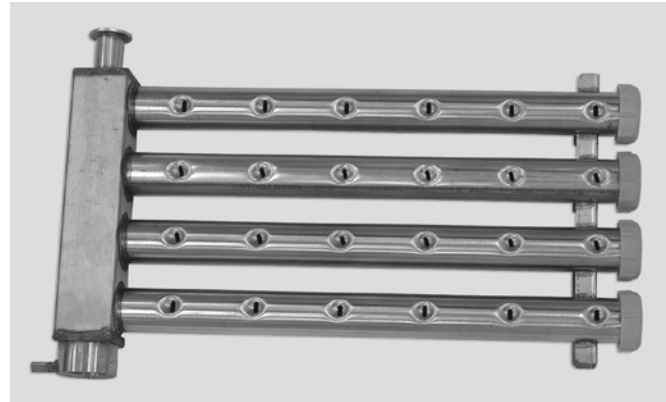
The insulated hinged inspection doors provide easy access in the chamber. Exterior wash pipes and reduced interior baffles reduce clean-up time. The Rapid Return drive allows for a wide separation between the wash and the rinse zone.



The Hobart exclusive microprocessor control module offers a choice of many features, such as an exclusive Energy Saver Mode, Low Temperature Alerts, and Dirty Water Indicator. It also displays pertinent machine status and has a Delime Notification. The controls have built-in Service Diagnostics and are NAFEM Data Protocol Compliant.



**Soil Management System.** Screen design sheds soil more easily than flat screens, reduces frequency of



**Wash Manifolds.** Computational Fluid Dynamic designed wash manifolds are self-aligning and come with Hobart's signature debossed anti-clogging nozzles for superior result.



**Opti-RinSe™.** Hobart's exclusive Opti-RinSe™ significantly reduces operating cost by reducing rinse water and the energy required to heat the water. The unique spray pattern uses large droplets to more efficiently sanitize the ware.

## OTHER STANDARD FEATURES . . .

- **Thermal Layer Curtains** help keep the heat inside the machine.
- **Ball Detent Clutch Conveyor Drive** for maximum protection against conveyor jams
- **Integrated Removable Pump Intake Screen** to offer the ultimate guard of keeping debris from entering the pump.
- **Hinged Door Seals** and stainless steel labyrinth seal for drip-free operation
- **Low-Temp Convertibility In Field.** All machines shipped hot. Change software in field at set up to low temperature if desired – then, if requirements change, convert from one mode to the other in the field. An exclusive feature – standard from Hobart.
- **Door Actuated Drain Closure.** Closing the door automatically actuates drain closure, eliminates extra manual steps, ensures that closure is in the



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# CL44e DISHWASHER

## AVAILABLE OPTIONS AND ACCESSORIES . . .

Flexibility is synonymous with Hobart CL<sub>e</sub> dishwashers. If your operation demands a dishwasher with a vent hood, an extended hood . . . a power scrapper, just specify the combination of options that suit your needs.



**Built-in Pressureless Stainless Steel Booster Heater.** Interwired and interplumbed. Saves on installation and saves floor space. Simplifies operation with just one switch to power dishmachine and booster.



**Side Loader.** Save up to 20 square feet in the dishroom layout with an optional C-Line Side Loader. Racks are indexed 90° into the dishwasher automatically – a feature that cuts space and reduces labor dramatically. Your dishroom team will appreciate this feature.

## OTHER AVAILABLE ACCESSORIES . . .

Blower-dryer, steam booster heater, and a single-point electrical connection to include electric booster

	CL44e
<b>Machine Ratings (Mechanical)</b>	
Racks per hour (19¾" x 19¾")	202
Conveyor Speed - feet per minute	5.6 max.
Dishes per Hour (Average 25 per rack)	5,025
Glasses per Hour (Average 45 per rack)	9,045
<b>Floor Space – Table to Table (Inches)</b>	44
<b>Overall Dimensions – H x W x D (Inches)</b>	68½ x 44¾ x 31¼
<b>Motor H.P.</b>	2
<b>Conveyor Drive H.P.</b>	½
<b>Number of Tanks</b>	1
<b>Tank Capacity – Gallons</b>	23
<b>Pump Capacity – Gallons per Minute - Weir Test</b>	165
<b>Heating Equipment – (For keeping power wash hot)</b>	
Gas Burners (with Natural Gas)	78,000 BTU per hr.
Electric Heating Unit – Size Used	15 KW
<b>Optional Booster Heater / Final Rinse</b>	15 KW / 30 KW
<b>Rinse – Minutes operated during hour of maximum operation</b>	60
<b>Final Rinse Flow – Gals. per min.</b>	
At 15 PSI Flow Pressure	1.8
At 20 PSI Flow Pressure	2.1
<b>Final Rinse Flow – Gals. per hr. – MAXIMUM</b>	
At 15 PSI Flow Pressure	108
At 20 PSI Flow Pressure	126
<b>Rinse 20 PSI Flow Pressure Gal./Rack</b>	Hot Water Sanitizing - Chemical Sanitizing .62 - 180°F – .62 - 120°F
<b>Steam Consumption – Pounds per hr. - MAXIMUM</b>	
Approx. 30 lbs. per hr. = 1 boiler H.P. (BHP) Dishwasher, based on 20 PSI steam and on customer supplying final rinse water at 180°F maximum	65
<b>Steam Booster, if used on 20 PSI steam - 20 PSI water flowing - 130°F entering water raised to 180°F min.</b>	60
<b>Exhaust Requirements – Cubic Feet per minute</b>	
Entrance End	200
Discharge End	400
<b>Peak Rate of Drain Flow – Gallons per minute. (Initial rate with full tank)</b>	38



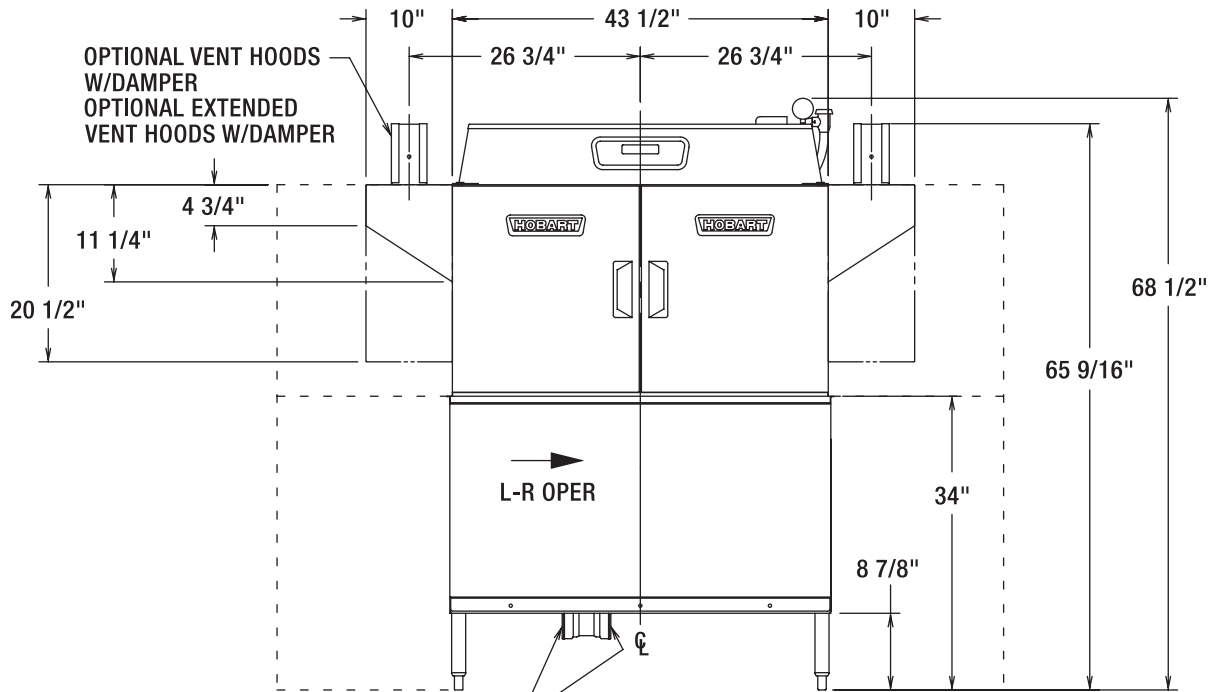
Fuller Middle School  
Framingham, MA

Item #: 59  
Quantity: 1

# CL44e DISHWASHER



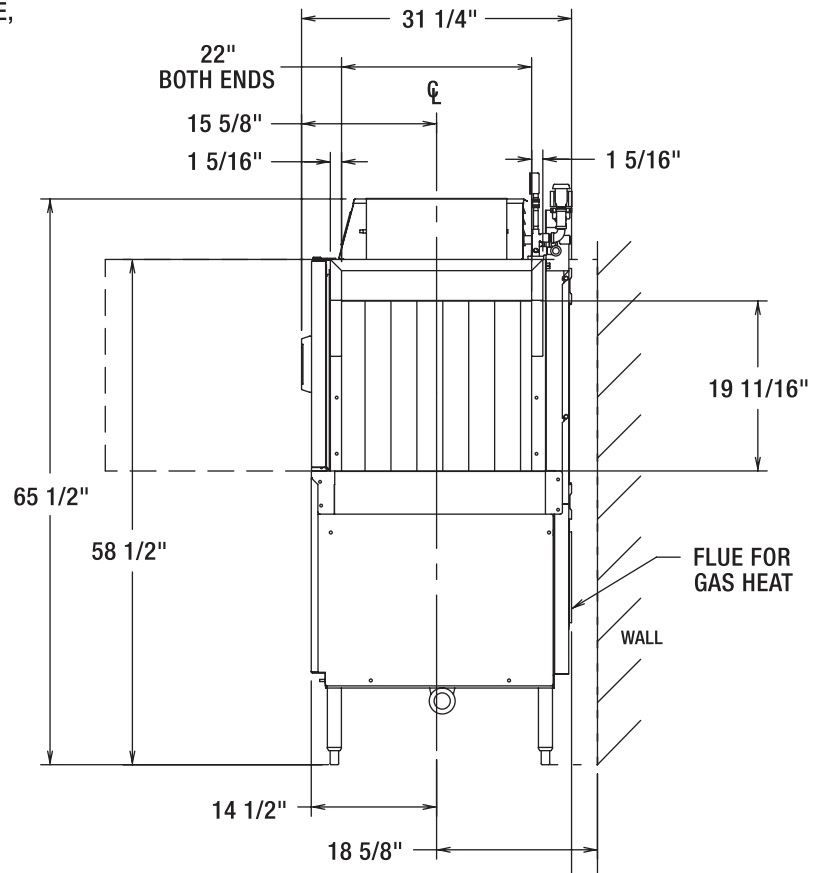
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MAY BE DRAINED TO EITHER SIDE OF VALVE, PLUG OPPOSITE SIDE.

BOOSTER HEAT 15 KW			
ELEC. SPECS.	RATED AMPS	MINIMUM SUPPLY CIRCUIT CONDUCTOR AMPACITY	MAXIMUM PROTECTIVE DEVICE
200-240/50/3	40.1	50	50
380-415/50/3	26.6	30	30
200/50/3	43.3	60	60
208-240/60/3	40.1	50	50
208/60/3	45.0	60	60
240/60/3	40.1	50	50
380/60/3	21.3	30	30
380-415/60/3	23.2	30	30
480/60/3	20.0	25	25
600/60/3	13.5	20	20

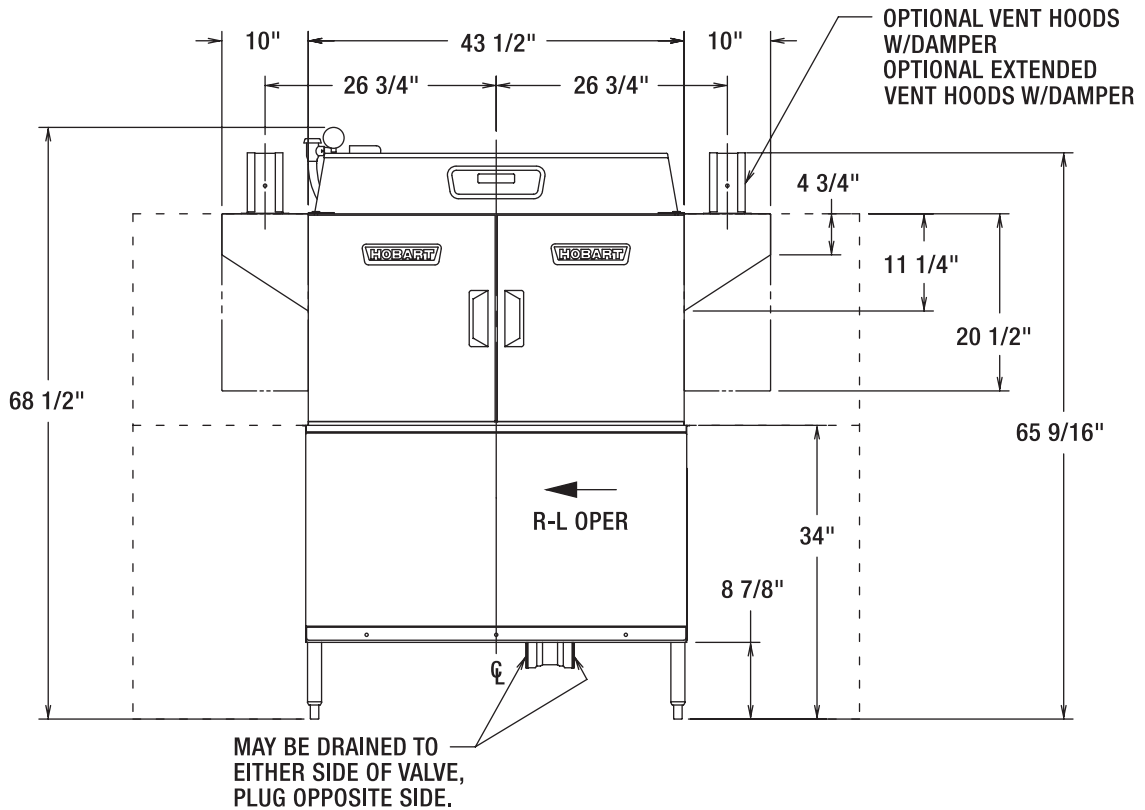
BOOSTER HEAT 30 KW			
ELEC. SPECS.	RATED AMPS	MINIMUM SUPPLY CIRCUIT CONDUCTOR AMPACITY	MAXIMUM PROTECTIVE DEVICE
200-240/50/3	80.2	90	90
380-415/50/3	53.2	60	60
200/50/3	80.8	90	90
208-240/60/3	80.2	90	90
208/60/3	83.9	90	90
240/60/3	80.2	90	90
380/60/3	42.5	60	60
380-415/60/3	46.4	60	60
480/60/3	40.1	50	50
600/60/3	26.7	40	40





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# CL44e DISHWASHER

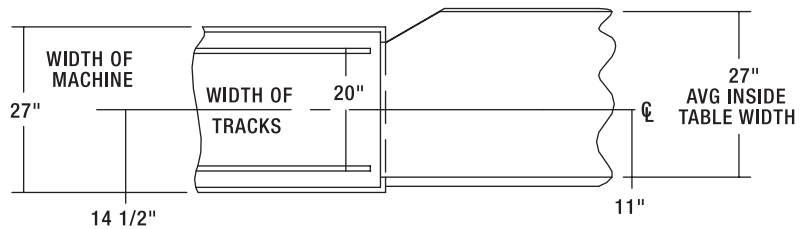


### WARNING

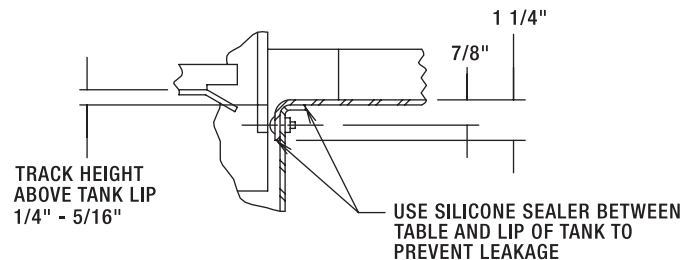
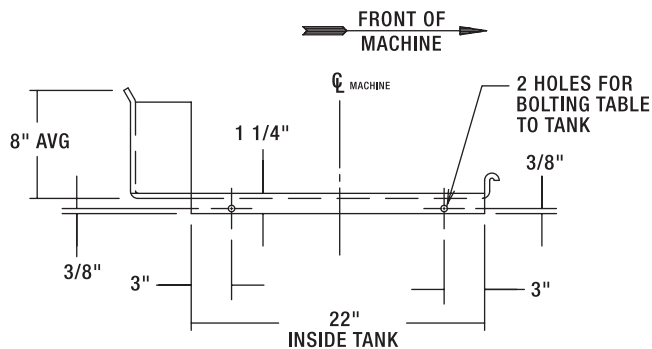
ELECTRICAL AND GROUNDING CONNECTIONS MUST COMPLY WITH THE APPLICABLE PORTIONS OF THE NATIONAL ELECTRICAL CODE AND/OR OTHER LOCAL ELECTRICAL CODES.

**CAUTION:** CERTAIN MATERIALS INCLUDING SILVER, ALUMINUM, AND PEWTER ARE ATTACKED BY SODIUM HYPOCHLORITE (LIQUID BLEACH).

**ATTN:** PLUMBING CONNECTIONS MUST COMPLY WITH APPLICABLE SANITARY, SAFETY, AND PLUMBING CODES.



SUGGESTED TRACK AND TABLE LAYOUT



Fuller Middle School  
Framingham, MA

Item #: 59  
Quantity: 1

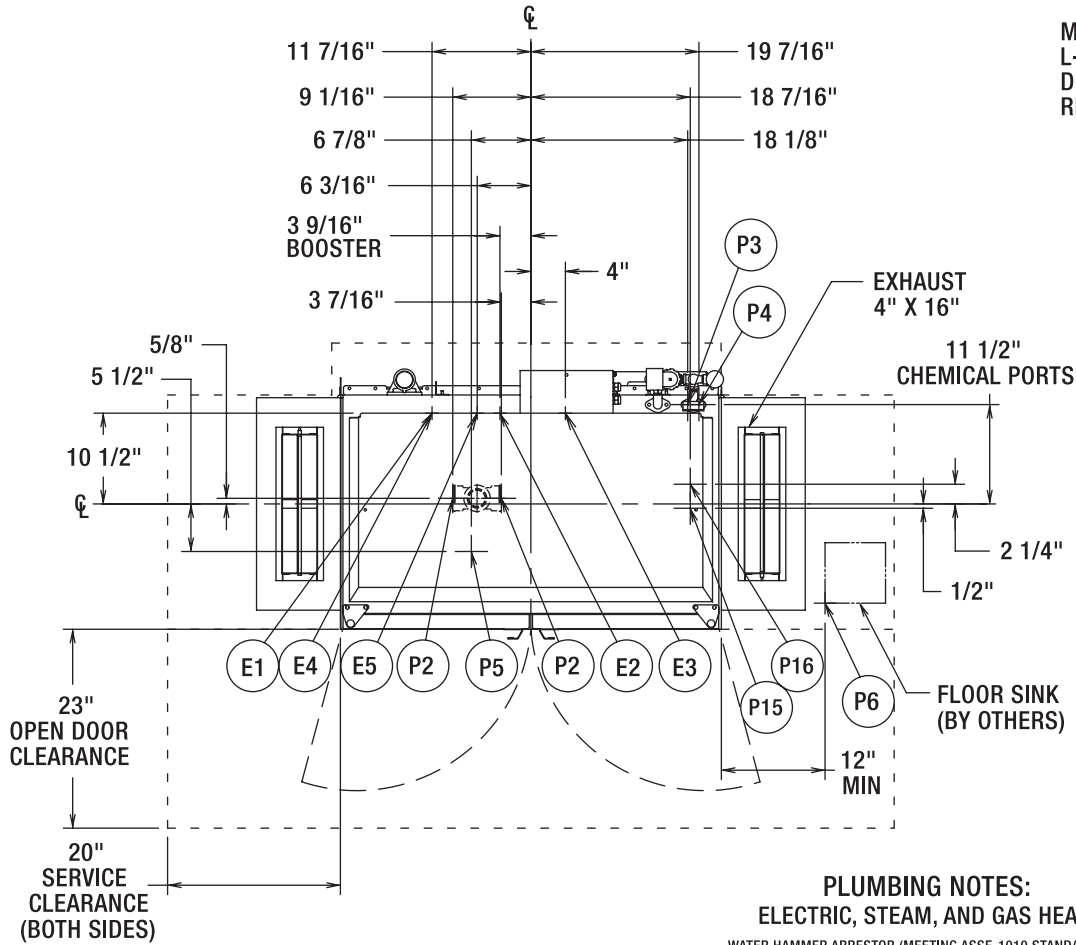


# CL44e ELECTRIC L-R



701 S Ridge Avenue, Troy, OH 45374  
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MODEL: CL44e  
L-R OPERATION  
D-936341  
REV C



### MISCELLANEOUS NOTES:

OPTIONAL VENT HOODS OR EXTENDED HOODS EXHAUST REQUIREMENTS: 200 CFM ENTRANCE END  
400 CFM EXIT END.

ALL DIMENSIONS TAKEN FROM FLOOR LINE MAY BE INCREASED APPROXIMATELY 3/4" OR DECREASED 1/2".

44" INSIDE TANK (AT TABLE CONNECTION)  
43-25/32" TABLE TO TABLE.

NET WEIGHT OF MACHINE: 501 LBS (STD HEIGHT),  
DOMESTIC SHIPPING WEIGHT: 576 LBS (STD HEIGHT).

### PLUMBING NOTES: ELECTRIC, STEAM, AND GAS HEATS

WATER HAMMER ARRESTOR (MEETING ASSE-1010 STANDARD OR EQUIVALENT) TO BE SUPPLIED (BY OTHERS) IN COMMON WATER SUPPLY LINE AT SERVICE CONNECTION.

RECOMMENDED WATER HARDNESS TO BE 3 GRAINS OR LESS FOR BEST RESULTS.

FOR NON-BOOSTER MACHINE (P15 CONN):  
RECOMMENDED BUILDING FLOWING WATER PRESSURE TO THE DISHWASHER IS 20 PSI, (15 PSI MIN - 25 PSI MAX).

IF PRESSURES HIGHER THAN 25 PSI ARE PRESENT, A PRESSURE REGULATING VALVE WITH INTERNAL THERMAL EXPANSION BY-PASS, MUST BE SUPPLIED (BY OTHERS) IN THE WATER LINE TO THE DISHWASHER.

FOR CONVENIENCE WHEN CLEANING, WATER TAP SHOULD BE INSTALLED NEAR MACHINE WITH HEAVY DUTY HOSE AND SQUEEZE VALVE.

WHEN USED, CHEMICAL SANITIZING FEEDER MUST BE CERTIFIED TO NSF STANDARD 29.

SEPARATE SERVICE CONNECTION FOR ELEC. HEAT

ELEC. HEAT 15 KW (WASH)			
VOLTAGE	RATED AMPS	MINIMUM SUPPLY CIRCUIT CONDUCTOR AMPACITY	MAXIMUM PROTECTIVE DEVICE
208/60/3	45	60	60
240/60/3	43	60	60
480/60/3	22	30	30
200/50/3	43	60	60
380/60/3	23	30	30
380-415/50/3	29	40	40
600/60/3	14.4	20	20
208/60/1	78	100	100

SEPARATE SERVICE CONNECTION FOR MOTORS ON ELEC. HEAT

MOTORS: 1/6 HP CONVEYOR 2 HP WASH			
VOLTAGE	RATED AMPS	MINIMUM SUPPLY CIRCUIT CONDUCTOR AMPACITY	MAXIMUM PROTECTIVE DEVICE
208/60/3	10	15	15
240/60/3	9.7	15	15
480/60/3	6.4	15	15
200/50/3	10.6	15	15
380/60/3	7.3	15	15
380-415/50/3	7	15	15
600/60/3	5.9	15	15
208/60/1	15.9	20	20

SINGLE POINT ELECTRICAL CONNECTION (3 PH ONLY) MOTORS AND ELECTRIC TANK HEAT

VOLTAGE	RATED AMPS	MINIMUM SUPPLY CIRCUIT CONDUCTOR AMPACITY	MAXIMUM PROTECTIVE DEVICE
208/60/3	55	70	70
240/60/3	52.6	70	70
480/60/3	27.9	40	40
200/50/3	53.9	70	70
380/60/3	30.1	40	40
380-415/50/3	31.8	40	40



Fuller Middle School  
Framingham, MA

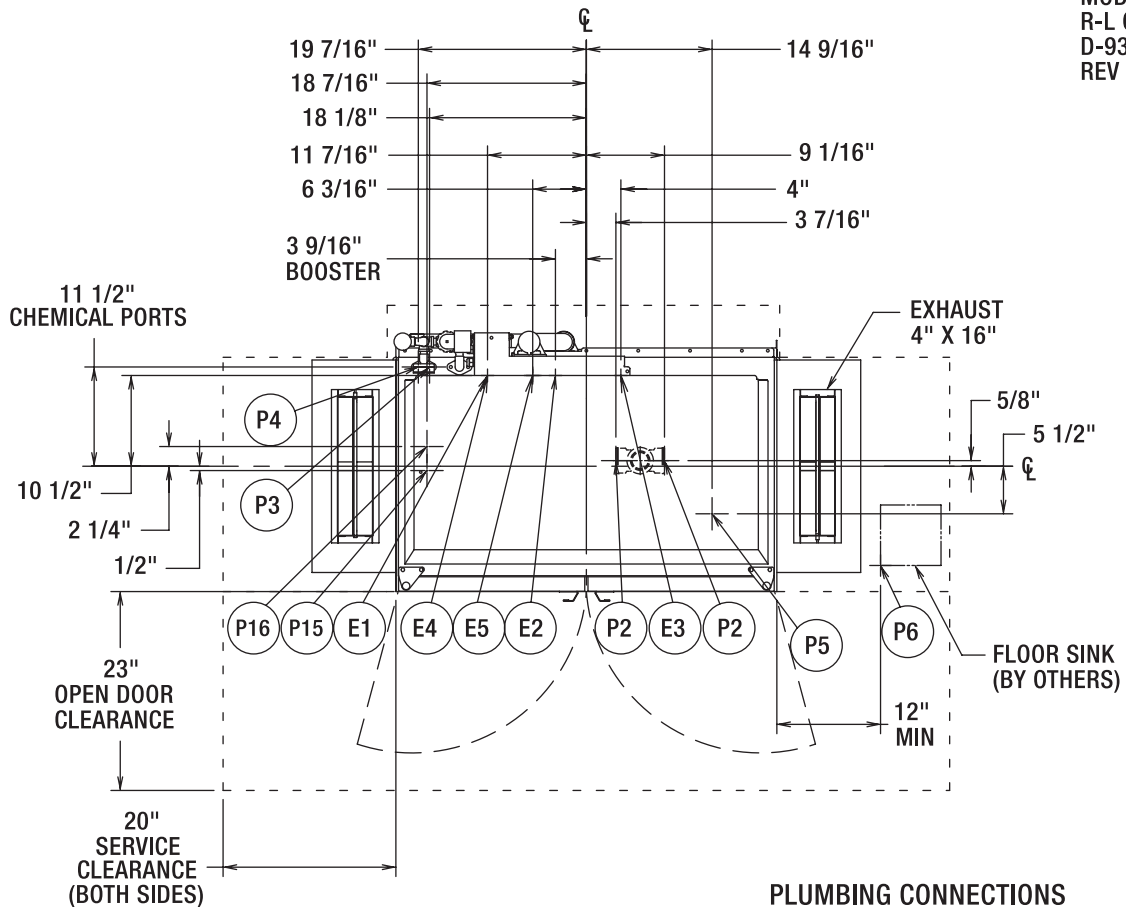
Item #: 59  
Quantity: 1



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# CL44e ELECTRIC R-L

MODEL: CL44e  
R-L OPERATION  
D-936340  
REV D



### PLUMBING CONNECTIONS CONNECTION INFORMATION (AFF = ABOVE FINISHED FLOOR)

### ELECTRICAL CONNECTIONS

#### CONNECTION INFORMATION (AFF = ABOVE FINISHED FLOOR)

#### LEGEND

#### ELECTRIC, STEAM, AND GAS HEATS

- E1 ELECTRIC CONNECTION: SINGLE POINT, ELEC, GAS, & STEAM, 1-1/4" CONDUIT HOLE OR 2" CONDUIT, 63-3/4" AFF
- E2 ELECTRIC CONNECTION: BOOSTER, 15KW/30KW, 1-1/4" CONDUIT HOLE OR 2" CONDUIT HOLE, 63-3/4" AFF
- E3 ELECTRIC CONNECTION: DETERGENT, SANITIZER (LOW TEMP ONLY) AND RINSE FEEDERS, 1/2" CONDUIT, 64-1/4" AFF

#### ELECTRIC HEAT ONLY

#### SINGLE PHASE OR FIELD CONFIGURED 3 PHASE SEPARATE ELECTRIC CONNECTION

- E4 ELECTRIC CONNECTION: MOTORS AND CONTROLS 1-1/4" CONDUIT, 63-3/4" AFF.
- E5 ELECTRIC HEAT: 15,000 WATTS, WASH TANK, 1" CONDUIT HOLE, 63-3/4" AFF.

### LEGEND

#### ELECTRIC, STEAM, AND GAS HEATS

- P2 DRAIN: 2" FPT, 7-3/8" AFF TWO POSSIBLE CONNECTIONS; MAY BE DRAINED TO EITHER SIDE OF VALVE, PLUG OPPOSITE SIDE.
- P3 SANITIZER FEEDER: REMOVE 1/8" NPT PIPE PLUG TO ACCESS TAPPED HOLE. 1/8" NPT 59-1/2" AFF (LOW TEMP ONLY)
- P4 RINSE FEEDER: REMOVE 1/8" NPT PIPE PLUG TO ACCESS TAPPED HOLE. 1/8" NPT 59-9/16" AFF.
- P5 DETERGENT PROBE SENSOR: REMOVE CAP AND STUD ASSEMBLY TO ACCESS 7/8" DIA HOLE (WASH TANK ONLY). 14-5/8" AFF.
- P6 INDIRECT DRAIN-FLOOR SINK: BY OTHERS, 0" AFF. WHEN REQUIRED, INSTALL FLOOR SINK OUTSIDE THE PERIMETER OF THE DISHWASHER.
- P15 COMMON WATER CONNECTION: 1/2" FPT, 11-3/16" AFF. HIGH TEMP. W/O BOOSTER 180°F MIN. 194°F MAX. LOW TEMP. 120°F MIN.
- P16 COMMON WATER CONNECTION: 1/2" FPT, 11-3/16" AFF HIGH TEMP. W/15K BOOSTER 140°F MIN. HIGH TEMP. W/30K BOOSTER 110°F MIN.
- P17 1/2" COLD WATER LINE NEAR THE DRAIN DISCHARGE IF THE OPTIONAL DRAIN WATER TEMPERING KIT IS INCLUDED



Fuller Middle School  
Framingham, MA

Item #: 59  
Quantity: 1

# CL44e DISHWASHER

**HOBART**701 S Ridge Avenue, Troy, OH 45374  
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**SPECIFICATIONS:** Meets requirements of A.S.S.E. Standard No. 1004.

**DESIGN:** Semi automatic, high or low temperature single-tank, rack-type dishwasher with flexible thermal layer curtains at the ends of chamber and between wash and final rinse zones. Insulated hinged inspection doors located in front of machine provide easy access to wash arms, rinse arms, strainer, strainer basket, and pump intake screen. Length of machine inside tank (at table connection) 44". Machine designed to clean and sanitize with hot water 160°F wash and 180°F (minimum) final rinse, or low temperature 130°F wash and 120°F final rinse and a chemical sanitizer. Water hardness recommended to be 3 gr. for best results. Automatic interlocks shut off pump and conveyor if door is opened when machine is in operation.

**CONSTRUCTION:** Tank, chamber, frame, legs, control box, doors, and all panels are constructed of stainless steel.

**PUMP:** The 165 gpm recirculating stainless steel pump and impeller with a ceramic seat seal. Easily accessible pump assembly permits quick inspection. The pump is self-draining. All piping distributing water to the upper and lower wash arms is stainless steel tubing.

**PUMP MOTOR:** Built for Hobart 2 hp grease-packed ball bearings, splash proof, ventilated with manual, resettable inherent overload protection. Available in electrical specifications of 208-240/60/1, 208-240/60/3, 480/60/3 and 600/60/3. Also available, but not submitted for UL listing are 200-240/50/3 and 380-415/50/3.

**CONTROLS:** A stainless steel control module with power and "start/stop" buttons is mounted on top of the machine. Machine control circuitry will be operated from a 120-volt control circuit transformer. Electrical components are completely wired with 105°C, 600V thermoplastic insulated wire with stranded conductors routed through UL listed electrical conduit or covered wire way.

**CONVEYOR:** Rapid Return drive, designed for more even throughput of racks and allows for a 16-inch separation between the wash and the rinse zone. Racks conveyed automatically through wash and rinse zones and onto clean dish table. Ball Detent Clutch drive prevents damage to machine or racks, should movement of racks be obstructed. Rack tracks, conveyor structure, and drive units of stainless steel for 19¼" x 19¼" racks as standard. Conveyor speed: 5.6 FPM.

**DRIVE MOTOR:** Built for Hobart, ½ horsepower gear motor, ventilated with manual, resettable inherent overload protection. Available in electrical specifications of 208-240/60/1, 208-240/60/3, 480/60/3 and 600/60/3. Also available, but not submitted for UL Listing are 200-240/50/3 and 380-415/50/3.

**POWER WASH:** Wash tank is equipped with upper and lower stainless steel CFD Wash Arms which effectively direct water jets to all ware surfaces. Both upper and lower wash arms are self-aligning and have easily removable end caps for cleaning without use of tools. A removable perforated stainless steel strainer pan supports a deep perforated stainless steel basket.

**FINAL RINSE:** Final rinse flow rate: 2.1 gpm, .62 gpr, 126-gph. Stainless steel upper and lower Auto Position Rinse Arms™ have single rows of nozzles. Racks entering the rinse zone automatically trigger rinse. Final rinse water line is equipped with a vacuum breaker downstream of an electrically operated

solenoid valve in common piping system. Rinse agent and Low Temp Final Rinse – Sanitizer agent (5.25% sodium hypochlorite – bleach) dispenser injection ports provided in final rinse piping above chamber. **Caution:** Certain materials, including silver, aluminum, and pewter are attacked by sodium hypochlorite (bleach) in the chemical sanitizing dishwasher mode of operation.

**FILL:** Fill water line is equipped with vacuum breaker on downstream side of electrically operated solenoid valve in common piping system, for automatic maintenance of tank level.

**DRAIN AND OVERFLOW:** Large bell-type automatic overflow and drain valve controlled from inside of machine. Drain automatically seats by closing inspection doors. Drain seal is large diameter, high temperature o-ring. Drain housing can be plumbed from load or unload end of machine.

**STANDARD EQUIPMENT:** Digital display of wash and final rinse temperature. Positive low water protection for tank heat. Thermal Layered Curtains throughout machine are keyed to ensure proper placement. Drain is automatically closed when inspection doors are closed. Stainless steel adjustable feet. Bolted stainless steel enclosure panels around perimeter and underneath machine. Automatic tank fill. Door interlock. Auto-timer. Vent fan and booster heater controls. Single point electrical connection. Low temperature alerts. Service diagnostics. Dirty water indicator. Delime notification. Conveyor dwell. Energy Saver Mode. NAFEM Data Protocol compliant.

#### WASH TANK HEATING SELECTIONS (must choose one):

**ELECTRIC:** One electric Incoloy® sheathed immersion heater (15 KW) removable from inside tank. Tank water temperature is controlled by microprocessor controlled thermostat with positive low-water protection and magnetic contactor. (Disconnect switches not furnished.) A high limit device mounted on the surface of the tank additionally protects heating element.

**STEAM:** One-inch stainless steel steam coil. Tank water temperature controlled by microprocessor controlled thermostat with positive low-water protection. Steam supplied to machine through high temperature steam solenoid valve and line strainer.

**GAS:** Regulated infrared immersion tube gas burner system. Microprocessor controlled thermostat and a blower with a pressure switch control tank water temperature. Positive low water protection is provided. A high limit device mounted on the surface of the tube additionally protects immersion tube. A solid-state igniter board controls the gas valve and provides flame ignition. A transformer steps the control circuit voltage down from 120 volts to 24 volts to power the igniter board and gas valve. For natural gas, gas pressure to burner (customer connection) not to exceed 7" W.C. For LP gas, gas pressure to burner (customer connection) not to exceed 11" W.C. If gas pressure is higher than 7" W.C. natural or 11" W.C. LP pressure regulating valve must be supplied (by others) in the gas line to the dishwasher.

#### OPTIONAL EQUIPMENT AT EXTRA COST:

Stainless steel pressureless booster heater. Stainless steel vent hoods with vent stack and locking-type damper. Higher than standard chamber. Side loaders and unloaders. Floor mounted steam booster. 19¼" x 19¼" peg, combination and miscellaneous racks. Table limit switch. Drain water tempering kit.

Fuller Middle School  
Framingham, MAItem #: 59  
Quantity: 1

**ITEM 60**

**CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION:** Vent Ducts

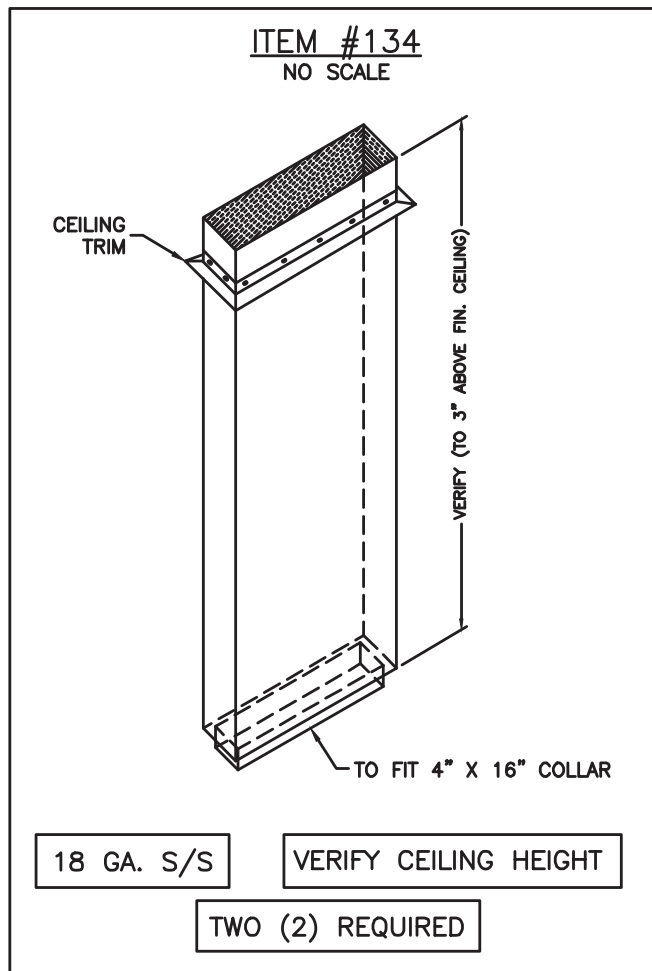
**NO CUT SHEET AVAILABLE**

**CONSTRUCTION FEATURES:**

Make - Fabricate per General Construction this Section

Size - 4" x 16" with length as necessary to reach 3" above finished ceiling

Construction - 18 gauge stainless steel welded exhaust ducts, sized to suit the vent stacks. Ducts shall be provided with a one-piece perimeter angle collar at the ceiling, installed "leg up".



**ITEM 61**

**CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION:**      **Clean Dish Table**

**NO CUT SHEET AVAILABLE**

**CONSTRUCTION FEATURES:**

Make - Fabricate per General Construction this Section

Size - 84" x 27" x 34" high plus 10" splash at rear; 3" high raised roll at front and end

Construction - 14 gauge stainless steel top and splash over channel frame with raised roll front and end, tall splash at rear, turned down into dishwasher and secured with stainless steel machine screws, and mounted on four legs with gussets, adjustable feet and undershelf. Secure table 3" off face of wall.

Item # \_\_\_\_\_

Quantity \_\_\_\_\_

# Stainless Steel Utility Carts

## Heavy Duty - 700 Lb Capacity



Model 744

**Angled "U" shaped steel frame provides the strength needed for heavy duty jobs.**

- Rugged 18 gauge reinforced stainless steel shelves are stain and rust resistant. Electronically welded for added strength.
- Easy to clean and sanitize, simply wipe down or steam clean.
- Leg and handle bumpers protect walls and furniture.
- NSF listed models available.
- 700 lb. (300 kg) capacity is ideal for continuous moving of heavy loads over various standard floor surfaces.



Spec. #

A/A #

# **LAKESIDE**

Lakeside Manufacturing, Inc.

4900 West Electric Avenue • West Milwaukee, WI 53219 U.S.A.

800-558-8565 • 414-902-6400 • Fax 414-902-6446 • www.eLakeside.com

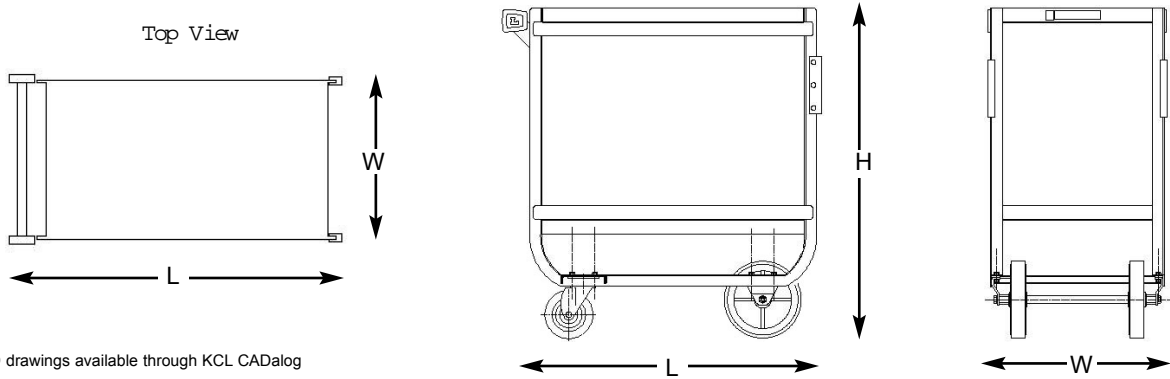


Fuller Middle School  
Framingham, MA

Item #: 4  
Quantity: 2

# Stainless Steel Utility Carts

Heavy Duty - 700 Lb Capacity



AutoCAD drawings available through KCL CADalog

## Dimensions

Model	NSF Listed Model	Shelf Description			Overall Size			Case Weight	
		# of	Size	Clearance	L	W	H	lbs.	(kg.)
710	510	2	15-1/2" x 24" (394 x 610)	19" (483)	30" (762)	16-1/4" (413)	34-1/4" (870)	49	(22.2)
711	511	3	15-1/2" x 24" (394 x 610)	10" (254)	30" (762)	16-1/4" (413)	34-1/4" (870)	57	(25.9)
721	521	2	18" x 27" (457 x 686)	19" (483)	32-5/8" (829)	19-3/8" (492)	34-1/2" (876)	53	(24)
722	522	3	18" x 27" (457 x 686)	10" (254)	32-5/8" (829)	19-3/8" (492)	34-1/2" (876)	63	(28.6)
743	543	2	21" x 33" (533 x 838)	21" (533)	38-5/8" (981)	22-3/8" (568)	37-1/8" (943)	64	(29)
744	544	3	21" x 33" (533 x 838)	11-3/8" (289)	38-5/8" (981)	22-3/8" (568)	37-1/8" (943)	78	(35.4)
758	558	2	21" x 49" (533 x 1245)	21" (533)	54-5/8" (1387)	22-3/8" (568)	37" (940)	87	(39.5)
759	559	3	21" x 49" (533 x 1245)	11-3/8" (289)	54-5/8" (1387)	22-3/8" (568)	37" (940)	108	(49)

Measurements in ( ) denote metric millimeters, unless otherwise specified.

## Specifications

Unit shall be of fully welded stainless steel construction. Legs and frame shall be of U-frame design, eliminating the need for corner reinforcements. Leg/frame shall be .120 x 1" x 1" angle stainless steel. Shelves shall be of 18-gauge stainless steel and shall be welded to vertical leg frames. Shelves shall be double hemmed on all four edges for extra rigidity. Unit shall have two each 5" (127 mm) diameter extra-load swivel casters with 1-1/4" (32 mm) wide non-marking polyurethane wheels, and two each 8" diameter extra-load wheels mounted to a fixed axle. Swivel casters shall be plate type and shall be bolted to an 18-gauge 5" (127 mm) wide stainless steel cross member with a galvanized reinforcement. Unit shall have push handle made of 18 gauge 1" O.D. stainless steel tubing. Handle mounting brackets shall be welded to vertical leg frame. Unit shall have two each bumpers mounted to handle ends and two each 6" (152 mm) vertical bumpers riveted to front legs.

### Optional Accessories

- Extended perimeter bumper
- All 5" swivel casters
- Set of 2 each 5" brake casters

AIA #

Spec. #

**LAKESIDE**® Lakeside Manufacturing, Inc.



Fuller Middle School  
Framingham, MA

Item #: 4  
Quantity: 2



**InterMetro Industries Corporation**  
 North Washington Street  
 Wilkes-Barre, PA 18705  
 www.metro.com

**Four tier with 63" high posts on casters**

## METROMAX Q™ SHELVING

with \*Microban Antimicrobial Product Protection

Part of the innovative MetroMax iQ™ Storage System, MetroMax Q™ is a longer life storage solution than conventional wire shelving. The product offers durable polymer mats that remove for easy cleaning and protect stored items from damage. Quick adjust shelves and MetroMax iQ accessories provides a very efficient use of storage space. MetroMax Q™ is integrated with online space planning tools and tutorials. [www.metro.com/iQ](http://www.metro.com/iQ)

- Longer-life performance:** Durable, corrosion proof polymer mats protect the shelves from normal wear and tear. Robust epoxy coated steel frames and posts hold as much weight as Metro's wire shelving. Weight capacity for evenly distributed loads:  
 800 lbs. (363kg) per shelf for lengths of 24" to 48" (610 to 1220mm)  
 600 lbs. (275kg) per shelf for lengths of 54" (1370mm) or longer  
 2,000 lbs. (907kg) maximum per stationary unit.
- Interchangeable:** MetroMax Q and MetroMax i™ shelves, posts, and most accessories are compatible on the same unit. Use MetroMax Q shelves with MetroMax i™ polymer posts for increased corrosion protection. Use MetroMax i™ solid shelves when spill containment is required or as a bottom shelf to protect supplies from dirt or backsplashes from mops.
- Easier to clean and maintain:** Polymer mats can be easily removed and cleaned in a sink or dish machine. Microban antimicrobial product protection is built into the high contact areas of the shelf including the mats, frames, and posts to protect the product from bacteria, mold, mildew, and fungus that cause odors and product degradation. Microban protection keeps the product "cleaner between cleanings".
- Quick to Adjust:** Patented corner release allows shelves to be unlocked without tools. Simply flip each corner release, relocate the wedge connectors on the posts, and reposition the shelf. Quickly adjust shelves to reclaim wasted vertical space.
- Smooth, Protective Surfaces:** Smooth shelf mats protect packaged items from unwanted rips, tears, or damage.
- Open Grid and Solid Mat Options:** MetroMax Q is available with open grid mats as standard. Open grid shelves promote air circulation and light penetration.  
 MetroMax i™ solid shelves can be used with MetroMax Q grid shelves on the same unit and are available in 18" and 24" (457 and 610mm) depths. For 21" (530mm) deep MetroMax Q, solid mat overlays are available.
- Efficient, Organized Storage:** Premium MetroMax iQ™ accessories efficiently organize, contain, and compartmentalize **all** space between shelves.
- Quick to Assemble:** MetroMax Q assembles easily in minutes, without tools. Shelves can be adjusted at 1" (25mm) increments along the post. Shelf wedges have a window to locate your desired position.



*MetroMax Q Mobile Unit*



*MetroMax Q with Accessories and MetroMax i Solid Bottom Shelf*

\*MICROBAN® and the MICROBAN® symbol are registered trademarks of the Microban Products Company, Huntersville, NC.



**MetroMax Q™ Polymer and Steel Shelving**

**9.21**



**Fuller Middle School**  
**Framingham, MA**

Item #: 63  
 Quantity: 3





## Specifications

- **Shelf frames and posts:** Steel with electroplated substrate and highly durable, abrasion-resistant epoxy finish. Epoxy finish has built-in Microban antimicrobial product protection. The adjustable foot is reinforced nylon.
- **Shelf Mats:** Injection molded polypropylene with exclusive built-in Microban® antimicrobial product protection.
- **Shelf Wedge Connector:** Reinforced nylon.
- **Temperature range:** -20°F (-29°C) to 125°F (52°C) continuous use, with intermittent exposure to 200°F (93°C) for cleaning.

## Standard Interchangeable Shelves

- Part number includes shelf with removable mats and one bag of wedges.
- MetroMax Q grid shelves, MetroMax i™ grid and solid shelves are all compatible on the same unit.

Nominal Width (in.) (mm)	Nominal Length (in.) (mm)	MetroMax Q Shelf with Grid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)	MetroMax i™ Shelf with Solid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)
18 457	24 610	MQ1824G	6.2 2.8	MX1824F	12.7 5.8
18 457	30 760	MQ1830G	8.0 3.6	MX1830F	14.5 6.6
18 457	36 914	MQ1836G	9.7 4.4	MX1836F	17.2 7.8
18 457	42 1060	MQ1842G	11.4 5.2	MX1842F	20.1 9.1
18 457	48 1220	MQ1848G	13.2 6.0	MX1848F	23.1 10.5
18 457	54 1372	MQ1854G	15.0 6.8	MX1854F	21.5 9.7
18 457	60 1524	MQ1860G	16.7 7.6	MX1860F	23.2 10.5
18 457	72 1829	MQ1872G	20.0 9.1	MX1872F	27.5 12.5
21 530	24 610	MQ2124G	8.0 3.6	—	—
21 530	30 760	MQ2130G	9.7 4.4	—	—
21 530	36 914	MQ2136G	11.4 5.2	—	—
21 530	42 1060	MQ2142G	12.8 5.8	—	—
21 530	48 1220	MQ2148G	14.5 6.6	—	—
21 530	54 1372	MQ2154G	16.7 7.6	—	—
21 530	60 1524	MQ2160G	18.5 8.4	—	—
21 530	72 1829	MQ2172G	21.7 9.9	—	—
24 610	24 610	MQ2424G	9.7 4.4	MX2424F	14.2 6.4
24 610	30 760	MQ2430G	11.4 5.2	MX2430F	15.9 7.2
24 610	36 914	MQ2436G	13.1 6.0	MX2436F	19.6 8.9
24 610	42 1060	MQ2442G	14.1 6.4	MX2442F	21.5 9.8
24 610	48 1220	MQ2448G	15.8 7.1	MX2448F	25.3 11.5
24 610	54 1372	MQ2454G	18.5 8.4	MX2454F	25.0 11.3
24 610	60 1524	MQ2460G	20.3 9.2	MX2460F	26.8 12.1
24 610	72 1829	MQ2472G	23.5 10.7	MX2472F	31.0 14.1

### Actual Dimensions:

Width: Add 3/16" (10mm) to nominal size.  
Length: Subtract 3/16" (5mm) from nominal size.



**MetroMax Q Open Grid Shelf**



**MetroMax i™ Solid Shelf**

## Heavy-Duty Dunnage Shelves

- Corrosion proof MetroMax i™ dunnage shelf is compatible with MetroMax Q.
- Open grid and solid version available.
- Weight capacity per shelf evenly distributed: 1,200 lbs. (544kg) on shelves up to and including 48" (1220mm) long; 900 lbs. (408kg) for shelves 60" (1524mm) long.
- Dunnage shelves are recommended for use on units with four posts.

Nominal Width (in.) (mm)	Nominal Length (in.) (mm)	Shelf with Grid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)	Shelf with Solid Mat Model No.	Approx. Pkd. Wt. (lbs.) (kg)
18 457	36 914	MHP1836G	18 8.2	MHP1836F	22 10.0
18 457	48 1220	MHP1848G	22 10.0	MHP1848F	26 11.8
18 457	60 1524	MHP1860G	26 11.8	MHP1860F	30 13.6

## Solid Mat Overlays

- Overlays snap onto the open grid mats to create a solid surface.
- Available for 21" (530mm) deep MetroMax Q shelves.

Fits Shelf		Model No.	Approx. Pkd. Wt.	
(in.)	(mm)		(lbs.)	(kg)
21x24	530x610	Q2124SM	0.35	0.16
21x30	530x760	Q2130SM	0.45	0.20
21x36	530x914	Q2136SM	0.50	0.23
21x42	530x1060	Q2142SM	0.60	0.27
21x48	530x1220	Q2148SM	0.70	0.32
21x54	530x1372	Q2154SM	0.80	0.36
21x60	530x1524	Q2160SM	0.90	0.41
21x72	530x1829	Q2172SM	1.00	0.45



**Fuller Middle School**  
Framingham, MA

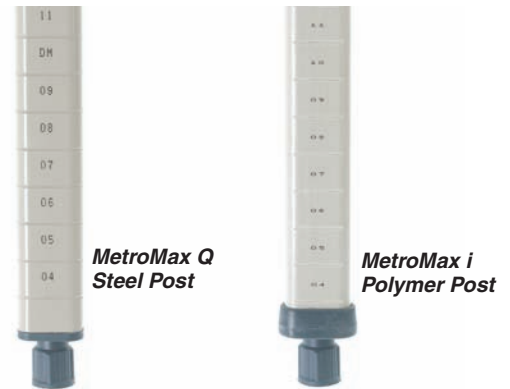
Item #: 63  
Quantity: 3

# METROMAX Q™ POLYMER AND STEEL SHELVING



## Standard Interchangeable Posts

- MetroMax Q: Epoxy coated steel with Microban antimicrobial product protection.
- MetroMax i: Polymer with Microban antimicrobial product protection.
- Stationary posts include an adjustable leveling foot to compensate for uneven floors. Leveling foot can be adjusted 1" (25mm).
- When mounting a shelving unit to a dolly base, stationary posts are used.
- Special height cut posts are available. Consult your Metro representative.



Nominal Height (in.) (mm)	Actual Height* (in.) (mm)	MetroMax Q Steel Model No.	STATIONARY POST WITH LEVELING FOOT				
			Approx. Pkd. Wt. (lbs.) (kg)		MetroMax i Polymer Model No.	Approx. Pkd. Wt. (lbs.) (kg)	
13 370	14 <sup>3</sup> / <sub>4</sub> 375	MQ13PE	1.0	0.5	MX13P	0.5	0.2
27 685	28 <sup>3</sup> / <sub>4</sub> 730	MQ27PE	2.0	0.9	MX27P	0.9	0.4
33 875	34 <sup>3</sup> / <sub>4</sub> 883	MQ33PE	2.5	1.1	MX33P	1.0	0.5
54 1370	54 <sup>3</sup> / <sub>4</sub> 1391	MQ54PE	4.0	1.8	MX54P	1.6	0.7
63 1585	62 <sup>3</sup> / <sub>4</sub> 1594	MQ63PE	4.5	2.0	MX63P	1.8	0.8
74 1690	74 <sup>3</sup> / <sub>4</sub> 1899	MQ74PE	5.5	2.5	MX74P	2.2	1.0
86 2195	86 <sup>3</sup> / <sub>4</sub> 2203	MQ86PE	6.5	2.9	MX86P	2.5	1.1

Replacement Leveling Foot:  
Model No. RPM3-FOOT

Replacement Post Cap for Steel Post:  
Model No. RPMQS-POSTCAP

Replacement Post Cap for Polymer Post:  
Model No. RPMXS-POSTCAP

Replacement MetroMax Q Wedges  
Model No. MQ9985 Bag of 4

Nominal Height (in.) (mm)	Actual Height* (in.) (mm)	MetroMax Q Steel Model No.	POST FOR STEM CASTER				
			Approx. Pkd. Wt. (lbs.) (kg)		MetroMax i Polymer Model No.	Approx. Pkd. Wt. (lbs.) (kg)	
13 370	13 <sup>3</sup> / <sub>4</sub> 349	MQ13UPE	1.0	0.5	MX13UP	0.5	0.2
27 685	27 <sup>3</sup> / <sub>4</sub> 705	MQ27UPE	2.0	0.9	MX27UP	0.9	0.4
33 875	33 <sup>3</sup> / <sub>4</sub> 857	MQ33UPE	2.5	1.1	MX33UP	1.0	0.5
54 1370	53 <sup>3</sup> / <sub>4</sub> 1365	MQ54UPE	4.0	1.8	MX54UP	1.6	0.7
63 1585	61 <sup>3</sup> / <sub>4</sub> 1568	MQ63UPE	4.5	2.0	MX63UP	1.8	0.8
70 1778	69 <sup>3</sup> / <sub>4</sub> 1765	MQ70UPE	5.0	2.3			
74 1690	73 <sup>3</sup> / <sub>4</sub> 1873	MQ74UPE	5.5	2.5	MX74UP	2.3	1.0
86 2195	85 <sup>3</sup> / <sub>4</sub> 2178	MQ86UPE	6.5	2.9	MX86UP	2.5	1.4



Replacement MetroMax Q Wedges  
MQ9985

### NOTE: Compatibility with existing Metro polymer mat shelving systems

- MQ9985 wedges are compatible with original MetroMax Q shelves and posts.
- The post centers on MetroMax Q have been changed to allow interchangeability with MetroMax i™ shelves. MetroMax Q shelves manufactured within or after April 2009 are not compatible with Q shelves made prior to April 2009.
- MetroMax Q is not compatible with original MetroMax manufactured prior to April 2009.
- Posts listed in above table (ex. MQ74PE, MX74PE) can be used with original MetroMax Q shelves made prior to April 2009.

## Post Clamp

Adds stability by joining posts of two separate units together. With it, each unit is supported by four posts and buttressed by the adjacent unit.

**Model No. 9994X**

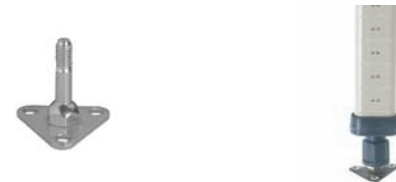


## Foot Plate

Use to add stability to the shelving unit or to bolt units to the floor.

**Model No. Zinc 9993Z**

**Model No. Stainless Steel 9993S**



## Stem Casters

A variety of stem casters are offered for MetroMax i™ mobile applications.

Stem caster models include bumpers.



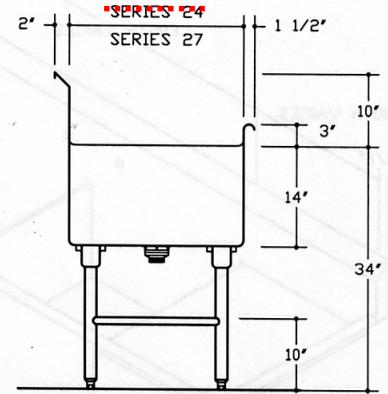
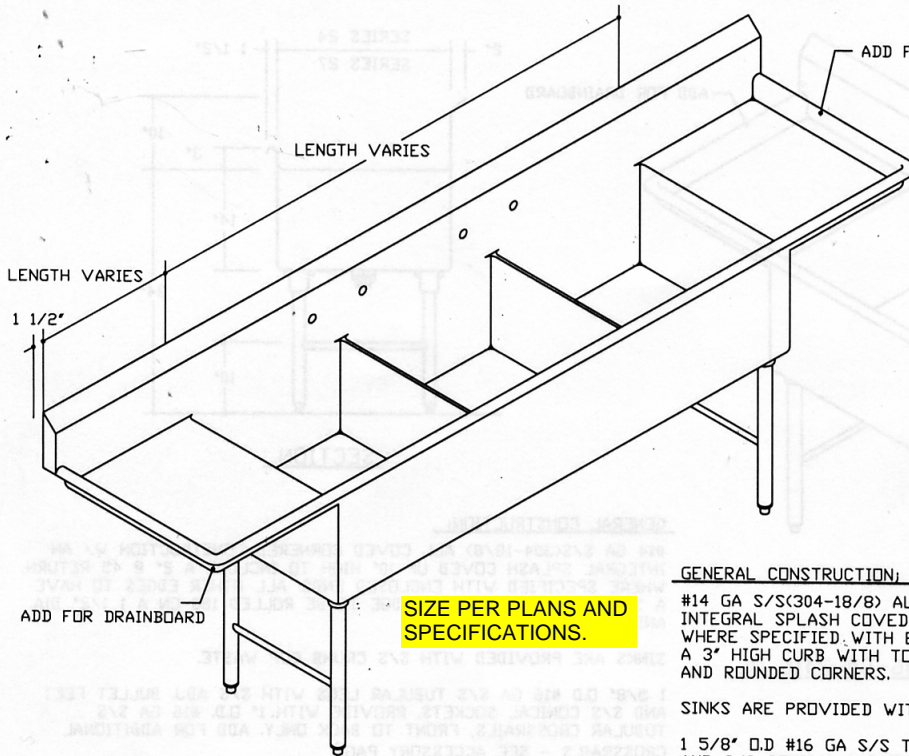
Replacement Bumper  
M9992DBX



Fuller Middle School  
Framingham, MA

Item #: 63  
Quantity: 3

# TRIPLE COMPARTMENT SINK



SECTION

SIZE PER PLANS AND SPECIFICATIONS.

S-3-2454-DB-2418-RL

GENERAL CONSTRUCTION:

#14 GA S/S(304-18/8) ALL COVERED CORNERED CONSTRUCTION W/ AN INTEGRAL SPLASH COVERED UP 10" HIGH TO INCLUDE A 2" @ 45 RETURN, WHERE SPECIFIED WITH ENCLOSED ENDS. ALL OTHER EDGES TO HAVE A 3" HIGH CURB WITH TOP EDGE TO BE ROLLED 180 ON A 1 1/2" DIA. AND ROUNDED CORNERS.

SINKS ARE PROVIDED WITH S/S CRUMB CUP WASTE.

1 5/8" D.D #16 GA S/S TUBULAR LEGS WITH S/S ADJ. BULLET FEET AND S/S CONICAL SOCKETS. PROVIDE WITH 1" D.D. #16 GA S/S TUBULAR CROSSRAILS, FRONT TO BACK ONLY. ADD FOR ADDITIONAL CROSSRAILS - SEE ACCESSORY PAGE

SERIES 24 - SINKS ONLY (ADD FOR DRAINBOARDS)		
MODEL #	LENGTH	WEIGHT
S-3-2418	54	150
S-3-2424	72	160
S-3-2427	81	170
S-3-2430	90	180

SERIES 27 - SINKS ONLY (ADD FOR DRAINBOARDS)		
MODEL #	LENGTH	WEIGHT
S-3-2718	54	160
S-3-2724	72	170
S-3-2727	81	180
S-3-2730	90	190

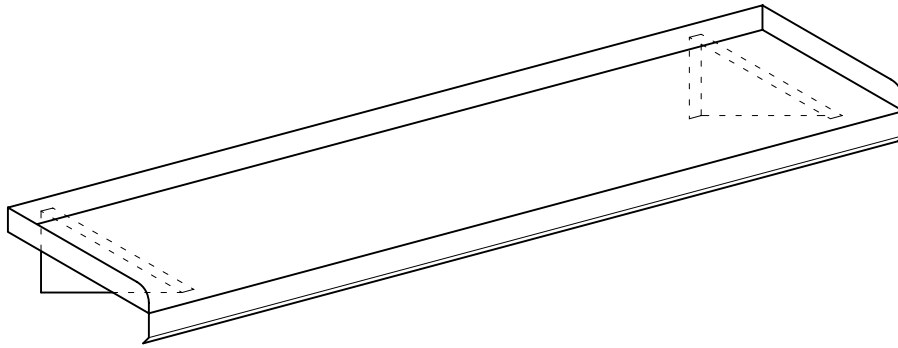
NOTE:

ON DRAINBOARDS OVER 30" LONG, ADD FOR ADDITIONAL SET OF LEGS AND CROSSRAILS, FRONT TO BACK

ALL DRAINBOARDS SHALL BE WELDED INTEGRAL WITH SINK SPECIFIED ABOVE  
FOR DRAINBOARD SPECIFY LEFT, RIGHT, OR BOTH END ATTACHMENT

SERIES 24 - DRAINBOARDS		
MODEL #	LENGTH	WEIGHT
DB-2418	18	26
DB-2424	24	34

SERIES 27 - DRAINBOARDS		
MODEL #	LENGTH	WEIGHT
DB-2718	18	28
DB-2724	24	36



## **CUSTOM FABRICATED FOODSERVICE EQUIPMENT**

**DESCRIPTION:**      **Wall shelf**

36" x 10" mounted 54" and 66" above finished floor

**NO CUT SHEET AVAILABLE**

### **CONSTRUCTION FEATURES:**

16 gauge stainless steel shelf

Rear and ends turned up 1-1/2" and corners welded

Front turned down 1-1/2" and in 1/2" at 45°

Mount on three 14 gauge stainless steel flag brackets with suitable anchors