Technical Specifications

for

GLENDALE UNIFIED SCHOOL DISTRICT

BALBOA ELEMENTARY SCHOOL
RELOCATABLE CLASSROOMS

Architect
NAC Architecture
837 North Spring Street 3rd Floor
Los Angeles, Ca 90012

Civil Engineer
Breen Engineering
1983 West 190th Street, Ste 200
Torrance, CA 90504

Architect's Project Number 161-17067
Date: MAY 1,2018

Electrical Engineer
Turpin & Rattan
2441 Honolulu Ave, Ste 200
Montrose, CA 91020

Prepared by
NAC Architecture

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SECTION 01420

TESTING AND INSPECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Testing and inspection services to meet requirements of the California Building Code (CBC), Title 24, Parts 1 and 2, as indicated on the Drawings.

B. One or more DSA certified inspectors employed by the OWNER in accordance with the requirements of California Building Standards Administrative Code will be assigned to the Work with their duties as specifically defined in Section 4-333(b).

C. Tests of materials are required by a DSA certified testing agency as set forth in Section 4-335 of the California Building Standards Administrative Code.

1.02 RELATED SECTIONS

A. Section 01120: Cutting and Patching
B. Section 01300: Submittals
C. Section 01365: Construction Schedule
D. Section 01450: Test and Balance
E. Section 01600: Materials and Equipment
F. Section 01700: Contract Closeout
G. Section 01740: Warranties

PART 2 – PRODUCTS (Not applicable)

PART 3 – EXECUTION

3.01 TESTS

A. OWNER will select an independent testing agency to conduct tests, sampling, and testing of materials. Selection of material to be tested shall be by the agency and not by CONTRACTOR.

B. Any material shipped from the source of supply prior to having satisfactorily passed such testing and inspection or prior to the receipt of notice from IOR such testing and inspection is not required shall not be incorporated into the Work.

C. OWNER will select and directly reimburse testing agency the costs for all DSA and/or DSA required tests and inspections, but may be reimbursed by CONTRACTOR for such costs as noted in related sections of the Contract Documents.

D. The independent testing agency is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents or approve or accept any portion of the Work. The agency shall not perform any duties of CONTRACTOR.

3.02 TEST REPORTS

A. Test reports shall include all tests performed, regardless of whether such tests indicate the material is satisfactory or unsatisfactory. Samples taken but not tested shall also be reported. Records of special sampling operations as required shall also be reported. Reports shall indicate the material or materials were sampled and tested in accordance with requirements of CBC, Title 24, Parts 1 and 2, as indicated on the Drawings. Test reports shall indicate specified design strength. They shall also definitely state whether or not material or materials tested comply with the specified requirements.

3.03 VERIFICATION OF TEST REPORTS

A. Each testing agency shall submit to the Division of the State Architect a verified report in duplicate covering tests which are required to be performed by that agency during progress of the Work. Such report shall be furnished each time construction on the Work is suspended, covering tests up to that time, and prior to Final Completion of the Work, covering all tests.

3.04 INSPECTION BY OWNER

A. OWNER and its representatives shall at all times have access, for purpose of inspection, to all parts of the Work and to shops wherein the Work is in preparation, and CONTRACTOR shall at all times maintain proper facilities and provide safe access for such inspection.

B. OAR shall have the right to reject materials and/or workmanship deemed defective Work, and to require correction. Defective workmanship shall be corrected in a satisfactory manner and defective materials shall be removed from the premises and legally disposed of, all without charge to OWNER. If CONTRACTOR does not correct such defective Work within a reasonable time, fixed by written notice and in accordance with the terms and conditions of the Contract Documents, OWNER may correct such defective Work and proceed in accordance with related Articles of the Contract Documents.

C. CONTRACTOR is responsible for compliance to all applicable local, state, and federal regulations regarding codes, regulations, ordinances, restrictions, and requirements.

3.05 INSPECTOR OF RECORD

A. Inspector of Record is employed by OWNER in accordance with requirements of Title 24 of the California Code of Regulations with their duties specifically defined therein.

B. Inspection of Work shall not relieve CONTRACTOR from any obligation to fulfill all of the terms and conditions of the Contract Documents.

C. CONTRACTOR shall be responsible for scheduling times of inspection, tests, sample taking, and similar activities of the Work.

3.06 TESTS AND INSPECTIONS

The following tests and inspections do not limit inspection of the Work but are required by DSA, other agencies, or are required in related Sections of the Contract Documents.

A. Concrete - CBC, Chapter 19A:

3. Inspection:

a.	Project Site Inspection	1905A.1
b.	Post-installed anchors in concrete	1916A.7

B. Wood - CBC, Chapter 23A:

1. Materials:

a.	Lumber and Plywood Grading	2303.1, 2304

END OF SECTION

SECTION 09 9000

PAINTING AND COATING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior and exterior painting.

B. Following items shall not be painted:

1. Brass valves, chromium or nickel-plated piping and fittings.

2. Boiler control panels and control systems.

3. Fabric connections to fans.

4. Flexible conduit connections to equipment, miscellaneous name plates, stamping, and instruction labels and manufacturer's data.

5. Mechanical and electrical utility lines, piping and heating and ventilation ductwork in tunnels, under-floor excavated areas or crawl spaces, attic spaces and enclosed utility spaces.

6. Flag, floodlight, parking light poles and loudspeaker poles, metal stairs, handrails and chain-link fence with a galvanized finish, unless otherwise noted.

7. Structural and miscellaneous steel, open web steel joists and metal floor decking, which will not be exposed in final construction, shall have no finish other than one coat of shop primer.

8. Hardboard covering on tops and backs of counters and benches.

9. Brass, bronze, aluminum, lead, stainless steel and chrome or nickel-plated surfaces.

10. Non-metallic walking surfaces unless specifically shown or specified to be painted.

1.02 REGULATORY REQUIREMENTS

A. Paint materials shall comply with the Food and Drug Administration’s (F.D.A.) Lead Law and the current rules and regulations of local, state and federal agencies governing the use of paint materials.

1.03 SUBMITTALS

A. List of Materials: Before submittal of samples, submit a complete list of proposed paint materials, identifying each material by distributor's name, manufacturer's name, product name and number, including primers, thinners, and coloring agents, together with manufacturers' catalog data fully describing each material as to contents, recommended installation, and preparation methods. Identify surfaces to receive various paint materials.

B. Material Samples: Submit manufacturer's standard colors samples for each type of paint specified. Once colors have been selected, submit Samples of each color selected for each type of paint accordingly:

1. Samples of Paint and Enamel must be submitted on standard 8 ½" x 11" Leneta Opacity-Display Charts. Each display chart shall have the color in full coverage. The sample shall be prepared from the material to be installed on the Work. Identify the school on which the paint is to be installed, the batch number, the color number, the type of material, and the name of the manufacturer.

2. Elastomeric shall be submitted in duplicate samples of the texture coating. Samples will be not less than 2 ½ by 3 ½ in size and installed upon backing. Finished Work will match the reviewed Sample in texture.

3. Materials and color samples shall be reviewed before starting any painting.

C. For transparent and stained finishes, prepare samples on same species and quality of wood to be installed in the Work, with written description of system used.

1.04 QUALITY ASSURANCE

A. Certification of Materials: With every delivery of paint materials, the manufacturer shall provide written certification the materials comply with the requirements of this section.

B. Coats: The number of coats specified is the minimum number. If full coverage is not obtained with the specified number of coats, install additional coats as required to provide the required finish.

C. Install coats and undercoats for finishes in strict accordance with the recommendations of the paint manufacturer as reviewed by the Architect.

D. Paint materials shall comply with the following as a minimum requirement:

1. Materials shall be delivered to Project site in original unbroken containers bearing manufacturer's name, brand number and batch number.

2. Open and mix ingredients on premises in presence of the Project Inspector.

1.05 DELIVERY, STORAGE AND HANDLING

A. Storage and Mixing of Materials: Store materials and mix only in spaces suitable for such purposes. Maintain spaces clean and provide necessary precautions to prevent fire. Store paint containers so the manufacturer's labels are clearly displayed.

1.06 SITE CONDITIONS

A. Temperature: Do not install exterior paint in damp, rainy weather or until surface has thoroughly dried from effects of such weather. Do not install paint, interior, or exterior, when temperature is below 50 degrees F, or above 90 degrees F, or dust conditions are unfavorable for installation.

1.07 WARRANTY

A. Manufacturer shall provide a three year material warranty.

B. Installer shall provide a three year application warranty.

1.08 MAINTENANCE

A. Provide at least one gallon of each type, color and sheen of paint coating installed. Label containers with color designation indicated on Drawings.

PART 2 - PRODUCTS

2.01 PAINT MATERIALS

A. Furnish the products of only one paint manufacturer unless otherwise specified or required. Primers, intermediate and finish coats of each painting system must all be the products of the same manufacturer, including thinners and coloring agents, except for materials furnished with shop prime coat by other trades.

B. Factory mix paint materials to correct color, gloss, and consistency for installation to the maximum extent feasible.

C. Paint materials to be minimum “Architectural Grade”.

D. Gloss degree standards shall be as follows:

HIGH GLOSS	70 and above	EGGSHELL	30 to 47
SEMI-GLOSS	48 to 69	SATIN	15 to 29

2.02 MANUFACTURERS

A. Acceptable manufacturers, unless otherwise noted:

1. Dunn-Edwards Corporation Paints

2. Frazee Paints and Wall coverings

3. Vista Paints

4. Sherwin Williams

5. ICI Paints

6. Equal.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine surfaces to receive paint finish. Surfaces which are not properly prepared and cleaned or which are not in condition to receive the finish specified shall be corrected before prime coat is installed.

B. New woodwork shall be thoroughly cleaned, hand sandpapered, and dusted off. Nail holes, cracks or defects in Work shall be filled. On stained woodwork, fill shall be colored to match stain. Filling shall be performed after the first coat of paint, shellac or varnish has been installed.

C. Plaster surfaces except veneer plaster shall be allowed to dry at least 3 weeks before painting. Veneer plaster shall be allowed to dry sufficiently to receive paint as determined by moisture meter tests.

D. Metal surfaces to be painted shall be thoroughly cleaned of rust, corrosion, oil, foreign materials, blisters, and loose paint.

E. Do not install painting materials to wet, damp, dusty, dirty, finger marked, rough, unfinished or defective surfaces.

F. Concrete surfaces shall be dry, cleaned of dirt and foreign materials and in proper condition to receive paint. Neutralize spots demonstrating effects of alkali.

G. Mask off areas where necessary.

3.02 APPLICATION

A. Backpainting: Immediately upon delivery to the Project site, finish lumber and millwork shall be backpainted on surfaces that will be concealed after installation. Items to be painted shall be backpainted with priming coat specified under "Priming".

B. Priming: New wood and metal surfaces specified to receive paint finish shall be primed. Surfaces of miscellaneous metal and steel not embedded in concrete, and surfaces of unprimed plain sheet metal Work shall be primed immediately upon delivery to the Project site. Galvanized metal Work and interior and exterior woodwork shall be primed immediately after installation. Priming of surfaces and priming coat shall be as follows:

1. Knots, Pitch and Sap Pockets: Shellac before priming.

2. Exterior Woodwork and Wood Doors: Prime with one coat of exterior waterborne emulsion wood primer.

3. Interior Woodwork: Where indicated to be painted, prime with one coat of waterborne wood primer.

4. Stain: Woodwork indicated to receive a stain and varnish finish shall be stained to an even color with water borne stain. On open-grained hardwood, mix stain with paste filler and completely fill pores in wood.

5. Galvanized Metal Work: Clean oil, grease and other foreign materials from surfaces. Install vinyl wash pretreatment coating. Follow manufacturer's instructions for drying time, and then prime with one coat of metal primer.

6. Unprimed Iron, Steel, and Other Uncoated Metals: Where specified to be painted, prime with one coat of metal primer.

7. Shop Primed Metal Items: Touch up bare and abraded areas with metal primer before installation of second and third coats.

8. Coats shall be installed evenly and with full coverage. Finished surfaces shall be free of sags, runs and other imperfections.

C. Allow at least 24 hours between coats of paint.

D. Rollers shall not be used on wood surfaces.

E. Each coat of painted woodwork and metal, except last coat, shall be sandpapered smooth when dry. Texture-coated gypsum board shall be sanded lightly to remove surface imperfections after first coat of paint has been installed.

F. Each coat of paint or enamel shall be a slightly different tint as required. Each coat of paint, enamel, stain, shellac, and varnish will be inspected by the IOR before next coat is applied. Notify the Project Inspector that such Work is ready for inspection.

1. Tinting Guideline: The first coat, primer/undercoat(s) to be untinted or tinted up to 50 percent lighter or darker (at the discretion of the installer) than the finish coat. The second coat (or third coat if a seal coat and undercoat have been specified) is to be factory tinted in the range of 10 percent to 15 percent lighter or darker (at the discretion of the installer) than the finish coat. The final coat is to be factory tinted to the required color selected. These tinting guidelines shall be provided on all surfaces receiving paint.

G. Do not "paint-out" UL labels, fusible links and identification stamps.

H. Paint Roller, brush and spray.

1. Only Paint rollers shall be used on interior plaster, drywall, masonry/plaster and plywood surfaces, nap shall not exceed one half inch in length.

2. First coat on wood overhang and ceilings shall have material applied by roller and then brushed out in a professional manner to leave surface free of imperfections. Finish coat may be sprayed.

3. Other surfaces shall have all coatings applied with brushes of proper size.

4. Spray work is permitted only on radiators, acoustic plaster, masonry and plaster.

I. Where ceilings are specified to be painted, beams, cornices, coves, ornamental features, plaster grilles, etc. shall be included.

J. Ceilings shall be white, including classrooms, storage rooms, offices, arcades, etc. Boiler room and fan room ceiling color shall match adjacent walls.

3.03 CLEANING

A. Remove rubbish, waste, and surplus material and clean woodwork, hardware, floors, and other adjacent Work.

B. Remove paint, varnish and brush marks from glazing material and, upon completion of painting Work, wash and polish glazing material both sides. Glazing material, which is damaged, shall be removed and replaced with new material.

C. Clean hardware and other unpainted metal surfaces with recommended cleaner. Do not furnish abrasives or edged tools.

3.04 SCHEDULE

A. Interior:

1. Woodwork, Painted: 3 coats.

a. First Coat: As specified in this section under Priming.

b. Second and Third Coats: Interior enamel, semi-gloss or gloss as indicated.

2. Woodwork, Stained and Varnished: 4 coats.

a. First Coat: As specified in this section under Priming.

b. Second, Third and Fourth Coats: Varnish, semi-gloss.

3. Wood Corridor doors: 4 coats.

a. First Coat: As specified in this section under Priming.

b. Second, Third, and Fourth Coats: Varnish, gloss.

4. Other Wood Doors: 4 coats.

a. Varnished or painted as indicated.

b. If varnished, same finish system as painted woodwork, with semi-gloss or gloss finish to match adjacent wall.

5. Miscellaneous Woodwork: 4 coats. Wood items including, but not limited to: stair treads and risers, handrails, rolling ladders, wood base and shoe, chair rails, counter tops and locker room benches.

   a. First Coat: As specified in this section under Priming.

   b. Second, Third and Fourth: Exterior varnish, gloss.

6. Casework: Interior surfaces of casework (except plastic laminate-faced casework) including top, edges and underside of shelving, poles, surfaces of drawers (except fronts), interior surfaces of mailbox pigeonholes, and particle board.

   a. First Coat: Waterborne stain.

   b. Second and Third Coats: Satin varnish.

7. Plaster: 4 coats.

   a. First Coats: Pigmented wall sealer.

   b. Second coat: Enamel under coater.

   c. Third and Fourth Coats – Interior enamel, semi-gloss or gloss as indicated.

8. Gypsum Board: 4 coats.

   a. First Coat: Drywall sealer.

   b. Second Coat: Enamel under coater.

   c. Third and Fourth Coats: Interior enamel, semi-gloss or gloss as indicated.

9. Concrete: 3 coats.

   a. First: Concrete sealer.

   b. Second and Third: Interior enamel, semi-gloss or gloss as indicated.

10. Metal: Shall be cleaned, pre-treated and painted with 3 coats. Items to be painted include, but are not limited to: exposed structural and miscellaneous steel, metal doors and frames, ladders, table and bench legs.

    a. First Coat: Metal primer.

b. Second and Third Coats: Interior gloss enamel, except metal doors and frames which shall be semi-gloss or gloss to match adjacent wall.

B. Exterior:

1. Woodwork: 3 coats.

a. First Coat: As specified in this section under Priming.

b. Second and Third Coats: Exterior house and trim enamel.

2. Wood Doors: 3 coats.

a. First Coat: As specified in this section under Priming.

b. Second and Third Coats: Exterior gloss enamel.

3. Plaster and Stucco: 3 coats. Flat 100 percent acrylic.

a. Prime Coat: Alkali resistant primer/sealer.

b. Exterior 100 percent acrylic.

4. Concrete: 3 coats. Flat 100 percent acrylic.

a. First Coat: Concrete sealer.

b. Second and Third Coats: Exterior 100 percent acrylic.

5. Metal: 3 coats. Shall be cleaned and pre-treated. Items to be painted include, but are not limited to: steel columns and miscellaneous steel items, gravel stops, metal doors and frames, hoods and flashings.

a. First Coat: As specified in this section under Priming.

b. Second and Third Coats: Exterior gloss enamel.

C. Mechanical and Electrical Work:

1. Except where interior mechanical and electrical Work to be painted is specified to receive another paint finish, Work occurring in finished rooms and spaces shall be cleaned, pre-treated, and painted with 3 coats. Items to be painted include, but are not limited to: steel and copper piping, pipes, vents, fittings, ducts, plenums, miscellaneous supports and hangers, electrical conduit, fittings, pull boxes, outlet boxes, unfinished surfaces of plumbing fixtures, miscellaneous metal cabinets, panels, and access doors and panels.

a. First Coat: As specified in this section under Priming.

b. Second and Third Coats: Interior enamel, semi-gloss or gloss to match adjacent wall or ceiling finish.

2. Insulation and Taping on Pipes and Ducts: 3 coats.

a. Finished Rooms:

1) First Coat: Interior waterborne primer.

2) Second and Third Coats: Interior semi-gloss or gloss enamel to match adjoining wall or ceiling finish.

b. Building Exterior:

1) First Coat: Exterior waterborne primer.

2) Second and Third Coats: Exterior gloss enamel.

3. Inside surfaces of ducts, vents, dampers and louvers as far back as visible from room in which they open shall be painted with 2 coats of flat black paint.

3.05 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.06 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to, the following:
   1. Examine all other sections for work related to those other sections and required to be included as work under this section.
   2. Electrical General Provisions and requirements for electrical work.
   3. Division-1; General Requirements; General Conditions.

B. Organization of the specifications into divisions, sections and articles, and arrangement of drawings shall not control the CONTRACTOR in dividing the contract work among subcontractors or in establishing the extent of work to be performed by any trade.

1.02 GENERAL SUMMARY OF ELECTRICAL WORK

A. The specifications and drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material for the proper execution of the work in accordance with present practice of the trade shall not relieve the CONTRACTOR from providing such additional labor and materials.

B. Refer to the drawings and shop drawings of other trades for additional details, which affect the proper installation of this work. Diagrams and symbols showing electrical connections are diagrammatic only. Wiring diagrams do not necessarily show the exact physical arrangement of the equipment.

C. Before submitting a bid, the CONTRACTOR shall become familiar with all features of the building drawings and site drawings, which may affect the execution of the work. No extra payment will be allowed for failure to obtain this information.

D. If there are omissions or conflicts between the drawings and specifications, clarify these points with the District's Representative before submitting bid and before commencing work.

E. Provide work and material in conformance with the manufacturer's published recommendations for respective equipment and systems.

1.03 LOCATIONS OF EQUIPMENT

A. The drawings indicate diagrammatically the desired locations or arrangements of conduit runs, outlets, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work so as to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structure conditions encountered.

B. Where outlets are placed on a wall, locate symmetrically with respect to each other, furniture, cabinets, and other features or finishes on the wall.

C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without cost to the contract, providing the change is ordered before the conduit runs, etc., and work directly connected to same is installed and no extra materials are required.

D. Lighting fixtures in mechanical spaces are shown in their approximate location only. Do not install light outlets or fixtures until mechanical piping and ductwork is installed; then install lights in a location to provide best lighting.

E. Coordinate and cooperate in every way with other trades in order to avoid interference and assure a satisfactory job.

F. The location of the existing utilities, building, equipment and conduit shown on the drawings is approximate. Verify exact locations and routing of existing systems by potholing all trench routes prior to digging the trench. Pothole at least 100 feet ahead of the actual trenching to allow space to alter the new conduit routing to accommodate existing conditions.

G. Underground Detection Services Existing Utility Structures
   1. Detection/location services shall be provided utilizing the latest detection equipment available. Services shall be performed by a company regularly engaged in the business of existing Underground Utility Structure Detection for the past five years.
   2. Prior to excavation and prior to directional boring the following work shall be performed:
      a. Contractor to mark excavating and trenching/ directional boring locations and indicate width and depth.
      b. Locate, by way of vertical and horizontal control dimensions, existing subgrade petroleum product pipes, process piping, conduits, sewer, water, gas, storm drain, electrical, telephone and irrigation lines in the affected areas of contract construction work.
      c. Arrange and meet with the District's Representative to review existing underground conditions.
      d. The proposed route of each excavation shall be continuously surveyed along the entire excavation path using ground-penetrating radar (GPR) operating from the surface grade. The GPR shall detect and map existing underground metal and non-metal, both private and public utility lines, pipes, conduits, conductors, etc. The GPR shall identify the horizontal and vertical location of existing underground conditions located at a depth of up to three (3) meters below finish grade and located with a vertical and horizontal accuracy within ± 12-inches of actual condition. The Contractor shall add this information to the existing conditions site plan.
   3. Exercise extreme caution in directional boring, excavating and trenching on this site to avoid existing underground utilities and structures, and to prevent hazard to personnel and/or damage to existing underground utilities or structures. The contract documents, drawings and specifications do not include necessary components for construction safety, which is the responsibility of the CONTRACTOR.
   4. Repair/replace, without additional cost to the contract, and to the satisfaction of the District any existing work damaged that was identified in the record drawings provided; Identified by the District's Representative; Identified by the Underground Detection Services performed; or any existing work damaged as a result of failure to comply with all the referenced requirements.
   5. The CONTRACTOR shall contact Common Ground Alliance (CGA) telephone #811 "Know What's Below-Call Before You Dig" and Underground Service Alert (USA), not less than 72-hours prior to excavation. Contractor shall not excavate until verification has been received from CGA and USA that existing underground utilities serving the site have been located, identified, and marked.

H. The locations of existing underground utilities, where shown on drawings, are shown diagrammatically and have not been independently verified by the District, the District's Representative, the Architect/Engineer. The District, the District's Representative, and the District's Architect/Engineer are not responsible for the location of underground utilities or structures, whether or not shown or detailed and installed under this or any other contracts. The CONTRACTOR shall identify each existing utility line prior to excavation and mark the locations on the ground of each existing utility line.

1.04 AIR CONDITIONING, HEATING, PLUMBING EQUIPMENT WIRING

Provide electrical work, materials, and control components required for proper operation of the air conditioning, heating and plumbing systems as indicated on the electrical, mechanical, and plumbing Contract Documents and specified herein.

1.05 POWER, TELEPHONE AND OTHER SIGNAL SERVICES

A. Telephone, cable television, power, street lighting service and metering facilities shall conform to the requirements of the serving utility companies. CONTRACTOR shall verify service locations and requirements, and shall pay all costs levied by the serving utility companies for rendering utility services to the contract without additional cost to the DISTRICT. Service information will be furnished by the serving utilities. Comply with requirements of the DISTRICT'S telephone supplier.

B. Conform to all requirements of the serving utility companies. Location of transformer pad and or manholes and pull boxes and routing of service conduits indicated on the drawings are approximate and shall be verified with the serving utility company prior to installation. Installation of service shall not begin until approved drawings have been received from the serving utility company.

C. Within 30-calendar days of receipt of notice that the contract award has been made, the CONTRACTOR shall notify the New Business Departments of the District Office of the serving utility companies concerning the project contract and shall provide information as to the total lighting, power, telephone, and signal requirements of the contract. The CONTRACTOR shall furnish at the same time information as to the estimated completion date of job or the date when the respective utility company circuits, will be ready for installation, energizing and activation of the respective services.

D. In addition to the requirements of the serving utility companies, all power, telephone and signal service conduits for utility company circuits, shall be completely encased in concrete on all sides, top and bottom. The concrete shall be red mix color and extend a minimum of three inches past the conduit.

E. Contractor shall submit Electrical Utility metering and electrical service entrance equipment shop drawings to the Electric Utility Company supplying the project for review and approval by the serving Utility Company. The submittal and acceptance by the Utility shall occur prior to submitting of shop drawings to the DISTRICT'S Representative or A/E for review. Copies of the serving Electrical Utility approval of the equipment shall be included in the shop drawings submittals to the DISTRICT'S Representative and A/E.

1.06 PERMITS

Take out and pay for all required permits, inspections and examinations without additional cost to the DISTRICT.

1.07 QUALITY ASSURANCE

A. Work and materials shall be in full accordance with the latest rules and regulations as follows. The following publications shall be included in the contract documents requirements. If a conflict occurs between the following publications and any other part of the contract documents, the requirements describing the more restrictive provisions shall become the applicable contract definition:
   1. California Code of Regulations Title 24.
   2. California Part 3 "California Electrical Code" CEC, Title 24 and Title 8 "Division of Industrial Safety".
   3. California Building Code - CBC.
   4. California Fire Code – CFC

5. The National Electrical Code – NEC/NFPA 70.
6. The Life Safety Code – NFPA 101.
7. The Uniform Building Code - UBC.
8. International Building Code – IBC.
9. National Fire Protection Agency-NFPA.
10. National Fire Alarm Code – NFAC/NFPA 72.
11. Underwriter's Laboratory-UL.
12. Other applicable State and Local Government Agencies laws and regulations.
13. Electrical Installation Standards National Electrical Contractors Association (NECA) and National Electrical Installation Standards (NEIS):
    a. NECA/NEIS-1: Standard of Practices for Good Workmanship in Electrical Contracting
    b. NECA/NEIS-101: Standard for Installing Steel Conduit (Rigid, IMC, etc.)
    c. NECA/NEIS-104: Recommended Practice for Installing Aluminum Building Wire and Cable
    d. NECA/NEIS-105: Recommended Practice Installing Metal Cable Trays
    e. NECA/NEIS-111: Recommended Practice Installing Nonmetallic Raceways
    f. NECA/NEIS-230: Recommended Practice for Installing Motors
    g. NECA/FOA-301: Standards for Installing and Testing Fiber Optic Cables
    h. NECA/NEIS-305: Standard for Fire Alarm System Job Practice
    i. NECA/NEIS–331: Standards for Installing Building and Service Entrance Grounding
    j. NECA/NEIS-400: Recommended Practice for Installing and Maintaining Switchboards k. NECA/NEIS-402: Recommended Practice for Installing and Maintaining Motor Control Centers
    l. NEIS/NECA and EGSA-404: Recommended Practice for installing Generator Sets
    m. NECA/NEIS-405: Recommended Practices for installing and Commissioning Interconnected Generation Systems
    n. NECA/NEIS-407: Recommended Practice for Installing Panelboards
    o. NECA/NEIS-408: Recommended Practices for Installing Busway
    p. NECA/NEIS-409: Recommended Practice for Installing and Maintaining Dry-Type Transformers
    q. NEIS/NECA and IESNA-500: Recommended Practice for Installing indoor Commercial Lighting Systems
    r. NEIS/NECA and IESNA-501: Recommended Practice for Installing Exterior Lighting Systems
    s. NEIS and IESNA-502: Recommended Practice for Installing Industrial Lighting Systems
    t. NECA/BICSI-568: Standards for Installing Commercial Building Telecommunications System
    u. NECA/NEIS-600: Recommended Practice Installing Medium-Voltage Cable

B. All material and equipment shall be new and shall be delivered to the site in unbroken packages. All material and equipment shall be listed and labeled by Underwriters Laboratories or other recognized testing laboratories, where such listings are available. Comply with all installation requirements and restrictions pertaining to such listings.

C. Work and material shown on the drawings and in the specifications is new and included in the contract unless specifically indicated as existing or N.I.C. (not in contract).

D. Keep a copy of all applicable codes and standards available at the job site at all times for reference while performing work under this contract. Nothing in plans or specifications shall be construed to permit work not conforming to the most stringent of building codes.

E. Where a conflict or variation occurs between applicable Codes, standards and/or the Contract Documents, the provisions of the most restrictive provision shall become the requirement of the Contract Documents.

1.08 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. General

1. Review of CONTRACTOR'S submittals is for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. CONTRACTOR is responsible for quantities; dimensions which shall be confirmed and correlated at the job site; fabrication processes and techniques of construction; coordination of work with that of all other trades and satisfactory performance of their work.
2. The CONTRACTOR shall review each submittal in detail for compliance with the requirements of the contract documents prior to submittal. The CONTRACTOR shall "Ink Stamp" and sign each item of the submittal with a statement "CERTIFYING THE SUBMITTAL HAS BEEN REVIEWED BY THE CONTRACTOR AND COMPLIES WITH ALL THE REQUIREMENTS OF THE CONTRACT DOCUMENTS". The CONTRACTOR shall clearly and specifically identify each individual proposed substitution, substitution of equal, or proposed deviation from the requirements of the contract documents with a statement "THIS ITEM IS A SUBSTITUTION".
   The burden of research, preparation of calculations and the furnishing of adequate and complete shop drawings information to demonstrate the suitability of CONTRACTOR's proposed substitutions and suitability of proposed deviations from the contract documents is the responsibility of the CONTRACTOR.
3. Departure from the submittal procedure will result in resubmittals and delays. Failure of the CONTRACTOR to comply with the submittal requirements shall render void any acceptance or any approval of the proposed variation. The CONTRACTOR shall then be required to provide the equipment or method without variation from the contract documents and without additional cost to the contract.
4. The CONTRACTOR at no additional cost or delays to the contract shall remove any work, material and correct any deficiencies resulting from deviations from the requirements of the contract documents not approved in advance by the DISTRICT prior to commencement of work.
5. Shop drawings submitted by the CONTRACTOR, which are not specifically required for submittal by the Contract Documents, or CONTRACTOR shop drawings previously reviewed and resubmitted without a written resubmittal request to the CONTRACTOR, will not be reviewed, considered, or commented on. The respective shop drawing submittal /resubmittal will not be returned to the CONTRACTOR and will be destroyed without comment or response to the CONTRACTOR. The respective submittal shall be considered null and void as being not in compliance with the requirements of the Contract Documents.
6. Refer to Division-1 for additional requirements.

B. Material Lists and Shop Drawings

1. Submit material list and equipment manufacturers for review within 35 days of award of contract. Give name of manufacturer and where applicable, brand name, type and/or catalog number of each item. Listing of more than one manufacturer for any one item of equipment, or listing items "as specified", without both make and model or type designation, is not acceptable. Shop drawings shall not be submitted before review completion of manufacturers list. The right is reserved to require submission of samples of any material whether or not particularly mentioned herein.
2. After completion of review of the material and equipment manufacturers list, submit shop drawings for review. Shop drawings shall be submitted in completed bound groups of materials (i.e., all lighting fixtures or all switchgear, etc.). The CONTRACTOR shall verify dimensions of equipment and be satisfied as to fit and that they comply with all code requirements relating to clear working space about electrical equipment prior to submitting shop drawings for review. Submittals, which are intended to be reviewed as substitution or departure from the contract documents, must be specifically noted as such. The

requirements of the contract documents shall prevail regardless of the acceptance of the submittal.

3. Shop drawings shall include catalog data sheets, instruction manuals, dimensioned plans, elevations, details, wiring diagrams, and descriptive literature of component parts where applicable. Structural calculations and mounting details, signed by a Structural ENGINEER registered by the State of California, shall be submitted for all equipment weighing over four hundred pounds, and shall be in compliance with Title 21 of the California Code of Regulations.
4. Each shop drawing item shall be identified with the specification section and paragraph numbers, lighting fixture types and drawing sheet numbers; the specific shop drawing is intended to represent. Shop drawings 11-inches by 17-inches or smaller in size shall be bound in three (3) ring binders. Divider tabs shall be provided in the three (3) ring binders identifying and separating each separate shop drawing submittal item. Shop drawings larger than 11-inches by 17-inches, shop drawing pages/sheets submittals shall be sequentially numbered with unique alphanumeric numbering system to facilitate correspondence referencing identification of individual sheets.
5. The time required to review and comment on the CONTRACTOR'S submittals will not be less than 14 calendar days, after receipt of the submittals at the office of FBA Engineering. The review of CONTRACTOR submittals and return to CONTRACTOR of submittals with review comments will occur in a timely manner conditioned upon the CONTRACTOR complying with all of the following:
   a. The submittals contain complete and accurate information, complying with the requirements of the Contract Documents.
   b. CONTRACTOR'S submittals are each marked with CONTRACTOR'S approval "stamp", and with CONTRACTOR signatures.
   c. The submittals are received in accordance with a written, shop drawing submittal schedule for each submittal. The CONTRACTOR distributes the schedule not less than 35-calendar days in advance of the Shop Drawing Submittals, and the schedule identifies the calendar dates, the CONTRACTOR will deliver the various submittals for review.
6. Shop drawings shall include the manufacturers projected days for shipment from the factory of completed equipment, after the CONTRACTOR releases the equipment for production. It shall be the responsibility of the CONTRACTOR to insure that all material and equipment is ordered in time to provide an orderly progression of the work. The CONTRACTOR shall notify the District's Representative of any changes in delivery, which would affect the project completion date.
7. Submittal Identification
   a. Each submittal shall be dated: with submittal transmission date; sequentially numbered and titled with submittal contents identification and applicable specification/drawing references *(i.e., Submittal dated: 5/12/98 Submittal #4 Contents: Branch circuit panelboards Sheet #E5.1 and transformers Specification Section 16050 Paragraph 2.11, etc.)*.
   b. Each resubmittal shall be dated: with original submittal date and resubmittal transmission dates; sequentially numbered with original submittal number and sequential resubmittal revision number and titled with submittal contents identification and applicable specifications/drawing references *(i.e., Original Submittal Date: 5/12/98 Resubmittal Date: 10/9/98 Original Submittal #4 resubmittal Revision R2 Contents: Transformer resubmittal Specification Section - 16050 Paragraph 2.11, etc.)*.
   c. Contractor shall provide a written response narrative with each resubmittal. Describe each response-action, resubmittal addition, change and deletion. Correspond each response to A/E specific review comment.

C. The CONTRACTOR shall be responsible for incidental, direct and indirect costs resulting from the CONTRACTOR'S substitution of; or changes to; the specified contract materials and work.

D. The CONTRACTOR shall pay, upon request by the District's Representative, a fee for the District's Representative time involved in the review of substitution submittals and design changes resulting from the CONTRACTOR'S requested substitutions. The fee shall be not less than $125.00 per hour but, in no case, less than stated in Division-1, whichever is greater.

E. Maintenance and Operating Manuals
   1. The CONTRACTOR shall furnish three (3) copies of type-written maintenance and operating manuals for all electrical equipment, fire alarm equipment, sound system equipment, etc., to the District.
   2. Instruct the District's personnel in correct operation of all equipment at completion of project. Provide the quantity and duration of instruction class as specified; but in no case less than two (2) 4-hour duration separate instruction classes for each individual equipment group furnished as part of the contract. Instruction classes shall be presented by Manufacturer's authorized field service ENGINEER at the project site. Instruction class size shall be at the District's discretion, not less than one (1) or more than fifteen (15) students shall attend each instruction session. Submit fifteen (15) written outline copies of the proposed instruction class curriculum, 14-days prior to the class-scheduled dates.
   3. Maintenance and operating manuals shall be bound in three-ring, hard-cover, plastic binders with table of contents. Manuals shall be delivered to the District's Representative, with an itemized receipt.

F. Portable or Detachable Parts: The CONTRACTOR shall retain in his possession, and shall be responsible for all portable and detachable parts or portions of the installation such as fuses, keys, locks, adapters, locking clips, and inserts until final completion of contract work. These parts shall then be delivered to the District's Representative with an itemized receipt.

G. Record Drawings (ADDITIONAL REQUIREMENTS)
   1. Provide and maintain in good order a complete set of electrical contract "record" prints. Changes to the contract to be clearly recorded on this set of prints. At the end of the project, transfer all changes to one set of transparencies to be delivered unfolded to the District's Representative.
   2. The actual location and elevation of all buried lines, boxes, monuments, vaults, stub-outs and other provisions for future connections shall be referenced to the building lines or other clearly established base lines and to approved bench marks. If any necessary dimensions are omitted from the record drawings, the CONTRACTOR shall, at THE Contractor's own expense, do all excavation required to expose the buried work and to establish the correct locations.
   3. The CONTRACTOR shall keep the "record" prints up to date and current with all work performed.
   4. Refer to Division-1 for additional requirements.

1.09 CLEANING EQUIPMENT, MATERIALS, PREMISES

All parts of the equipment shall be thoroughly cleaned of dirt, rust, cement, plaster, etc., and all cracks and corners scraped out clean. Surfaces to be painted shall be carefully cleaned of grease and oil spots and left smooth, clean and in proper condition to receive paint finish.

1.10 JOB CONDITIONS - PROTECTION

Protect all work, materials and equipment from damage from any cause whatever and provide adequate and proper storage facilities during the progress of the work. Provide for the safety and good condition of all the work until final acceptance of the work by the District and replace all damaged or defective work, materials, and equipment before requesting final acceptance.

1.11 EXCAVATION, CUTTING, BACKFILL AND PATCHING ADDITIONAL REQUIREMENTS

A. General
   1. Perform excavation, cutting, backfill, core drilling, directional boring, and patching of the construction work required for the proper installation of the electrical work.
   2. Patching shall be of the same material, thickness, workmanship, and finish as existing and accurately match-surrounding work to the satisfaction of the District's Representative.
   3. Prior to penetrating, coring, drilling or cutting existing building elements, concrete and/or masonry, provide imaging equipment examinations of each specific location. The imaging process shall identify existing internal embedded components and locations, including structural elements/anchors, conduit, and piping that are present. Do not penetrate or damage the existing internal embedded elements. Imaging shall employ one (1) of the following, with GPR methodology preferred:
      a. Non-invasive imaging employing high frequency, ground penetrating radar (GPR), single side echo reflection technology.
      b. Non-invasive imaging employing x-ray radiography, through-and-through imaging technology.

B. Excavation Temporary Cover
   1. Excavations for contract work occurring in streets, vehicular drive areas, parking lots, sidewalks; any paved surface; or any area accessible to the public; provide temporary steel plating and shoring support for the plates, to completely cover the excavations under one or more of the following conditions:
      a. Excavation shall not remain "open" for more than 4-calendar days; provide temporary plating.
      b. Excavation shall not be "open" over weekends (Saturday, Sunday) or Holidays; provide temporary plating.
   2. The temporary plating shall be a minimum of 0.75-inch thickness steel, but in no case shall the thickness be less than required to support AASHO-H20 traffic loading.
   3. Provide a minimum of two (2) 100% open lane(s) (12-foot lane width) for vehicular traffic at all times during construction, for vehicle access to all areas.

1.12 IDENTIFICATION

A. Equipment Nameplates
   1. Panelboards, terminal cabinets, circuit breakers, disconnect switches, starters, relays, time switches, contactors, push-button control stations, and other apparatus used for the operation or control of feeders, circuits, appliances, or equipment shall be properly identified by means of descriptive nameplates or tags permanently attached to the apparatus and wiring.
   2. Provide nameplate label on electrical service entrance equipment describing available short circuit information calculated by the CONTRACTOR, including:
      a. Calculation date, month-day-year.
      b. Calculate maximum available short circuit fault current.
      c. Description of parameters and changes affecting the requirements for recalculation of the fault current information.
   3. Electrical equipment including switchgear, switchboards, electric panels and control panels, motor control centers, combination motor starters, transformers, disconnects, etc., shall each be labeled by the manufacturer with "Electric-ARC-FLASH" warning signs. The signs shall explain a hazard to personnel may exist if the equipment is worked on while energized or operated by personnel while energized. The sign shall instruct personnel to wear the correct protective equipment/clothing (PPE) when working "Live", or operating "Live" electrical equipment and circuits.
   4. Nameplates shall be engraved laminated phenolic. Shop drawings with dimensions and format shall be submitted before installation. Attachment to equipment shall be with

escutcheon pins, rivets, self-tapping screws or machine screws. Self-adhering or adhesive backed nameplates shall not be used.

5. Provide black-on-white laminated plastic nameplates engraved in minimum ¼-inch high letters to correspond with the designations on the drawings. Provide other or additional information on nameplates where indicated.

B. Plates: All cover and device plates shall be furnished with engraved or etched designations under any one of the following conditions (minimum character size not less than 0.188 inch. Engraving shall indicate circuits and equipment controlled or connected):
   1. More than two (2) devices under a common coverplate.
   2. Lock switches.
   3. Pilot switches.
   4. Switches in locations from which the equipment or circuits controlled cannot be readily seen.
   5. Manual motor starting switches.
   6. Where so indicated on the drawings.
   7. As required on all control circuit switches, such as heater controls, motor controls, etc.
   8. Receptacles other than standard 15 ampere 120 volt duplex receptacles; shall indicate circuit voltage, ampere, phase and source circuit number.
   9. Where outlets or switches are connected to emergency power circuit; provide panelboard and circuit number engraved on plate.
   10. Low voltage and signal system outlets.

C. For equipment and access doors or gates to equipment containing or operating on circuits of more than 100 volts AC or DC nominal. Provide red-on-white laminated warning signs engraved in ½-inch high letters to read: "DANGER - 480 *(or applicable voltage)* VOLTS KEEP OUT AUTHORIZED PERSONNEL ONLY".

D. Wire and Cable Identification
   1. Provide identification on individual wire and cable including signal systems, fire alarm, electrical power systems (each individual phase, neutral and ground), empty conduit pull ropes, and controls circuit.
   2. Permanent identification shall be provided at each termination location, splice location, pullbox, junction box and equipment enclosure.
      a. Individual wire and cable larger than #6AWG or 0.25-inch diameter, shall be provided with polypropylene identification tag holders, with yellow polypropylene tags interchangeable black alphanumeric characters, character height 0.25 inch. Attach identification tags with plastic “tie” wraps, minimum of two (2) for each tag. As manufactured by Almetek Industries-“EZTAG” series; or TECH Products - “EVERLAST” series.
      b. Individual wire and cable #6AWG and smaller or smaller than 0.25 inch diameter, shall be provided with water and oil resistant, flexible, self-laminating pressure sensitive machine embossed plastic tags that wrap a minimum of 360 degrees around the wire/ cable diameter. The entire tag shall then be covered with a clear flexible waterproof plastic cover wrapped a minimum of 540 degrees around the wire/cable diameter and completely covering the identification. As manufactured by Brady Identification; or 3M; or Panduit.
      c. Each identification tag location shall indicate the following information: circuit number, circuit phase, source termination and destination termination equipment name (or outlet number as applicable).
   3. Install permanent identification after installation /pulling of wire/cable is complete, to prevent loss or damage to the identification.

E. Cardholders and cards shall be provided for circuit identification in panelboards. Cardholders shall consist of a metal frame retaining a clear plastic cover permanently attached to the inside

of panel door. List of circuits shall be typewritten on card. Circuit description shall include name or number of circuit, area, and connected load.

F. Junction and pull boxes shall have covers stenciled with box number when shown on the drawings, or circuit numbers according to panel schedule. Data shall be lettered in a conspicuous manner with a color contrasting to finish.

1.13 TESTING

A. The CONTRACTOR shall obtain an independent testing laboratory, provide all instrumentation and perform tests on the electrical system and equipment as hereinafter described and further directed by the District's Representative. The test shall be performed after the completion of all electrical systems included in the Contract Scope of Work. All tests shall be recorded and documented and submitted to the District's Representative for review.
   1. All equipment and personnel required for set-up and testing shall be provided by the CONTRACTOR.

B. Test for Phase to Ground and Neutral Condition:
   1. Open main service disconnects.
   2. Isolate the system neutral from ground by removing the neutral disconnects link located in the service switchboard.
   3. Close all submain disconnects.
   4. Close all branch feeder circuit breakers.
   5. Turn all switches to "on" position, unplug all portable equipment from outlet receptacles.
   6. Measure the resistance of each phase to ground and phase to neutral. A properly calibrated "megger" type test instrument shall be used. The test voltage shall be a nominal 500 volts.
   7. Record all readings after 1-minute duration and document into a complete report.
   8. Isolating Grounds: In the event that low resistance ground neutral connections are found in the system, they shall be isolated and located by testing each circuit individually as outlined above. Make proper corrections to restore the resistance values to an acceptable value.

C. Method of obtaining ground resistance shall be in accordance with the latest edition of the James G. Biddle (Plymouth Meeting, Pennsylvania) manual published on this subject.
   1. Perform "fall-of-potential" three (3) point tests on the main grounding electrode of system per IEEE Standard No. 81, Section 8.2.1.5. when suitable locations for test rods are not available, a low resistance dead earth or reference ground shall be utilized.
   2. Perform the two (2) point method test per IEEE Standard No. 81, Section 8.2.1.1, to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

D. The testing, calibrating and setting of all ground and ground fault equipment, circuit breakers, circuit device protection relays, and meters adjustable settings shall be by an independent testing laboratory. Set as recommended by the respective manufacturer and coordination study so as to be coordinated with other protection devices within the electrical design. Bound and tabulated copies of the test and settings shall be sent to the District's Representative.

E. Ampere and Voltage Measurements
   1. Measure and record ampere and line voltage measurements under full load on all panel feeders, switchboard, and switchgear feeders, motor control centers and motor circuits provided in the contract. Record measurements at the equipment tested and submit to the District's Representative for review.
   2. Ampere voltage readings shall be:
      a. Phase A-B, A-C and B-C.
      b. Phase A-Neutral, B-Neutral and C-Neutral.
   3. The ampere and voltage readings shall be not less than 20-minutes duration for each test. Record and submit the measured minimum, maximum and 20-minute average for each

ampere and voltage value and test location. Voltage and ampere measurements shall occur at the connected load end of each respective feeder, not at the source of supply end of each feeder.

4. Test equipment shall be accurate within plus or minus 1%.
5. Branch circuit devices 40 ampere or less and motor loads ten (10) horsepower or smaller are excluded from ampere and voltage testing requirement.
6. If, in the opinion of the District's Representative, the voltages and regulations are not met within acceptable limits, make arrangements with the serving utility for proper electrical service. Retest feeder line voltages, and submit to District's Representative for review, after the utility company has completed corrective actions. Reset "voltage taps" on transformers provided or modified as part of the contract work, to adjust line voltages to within acceptable values, as directed by the District's Representative.

F. The Contractor shall complete the following work before any electrical equipment is energized.
1. All equipment shall be permanently anchored.
2. All bus connections and conductor/wire connections shall be tightened per manufacturer's instructions and witnessed by the District's Representative.
3. All ground connections shall be completed and identified. Perform and successfully complete all required megger and ground resistance tests.
4. Feeders shall be connected and identified.
5. The interiors of all electrical enclosures including busbars and wiring terminals shall be cleaned of all loose material and debris, paint, plaster, cleaners or other abrasive's over spray removed and equipment vacuumed clean. The District's Representative shall observe all interiors before covers are installed.
6. All wall, ceiling, and floor work and painting shall be completed within areas containing electrical equipment prior to installation of equipment. The equipment indoor rooms and spaces shall be weather-tight and weather protected from environmental incursions.
7. All doors to electrical equipment rooms shall be provided with locks in order to restrict access to energized equipment.
8. Electrical spaces and rooms shall not be used as storage rooms after power is energized.
9. Outdoor electrical equipment enclosures and housings shall be weather protected.
10. The electrical system time current coordination and ARC-Fault study shall be complete for circuit breakers, ground relays sets, and circuit relay sets, fuses; set-up, tested and calibrated accordingly.

1.14 COMMISSIONING - Cx

A. General
1. The commissioning shall verify the electrical systems for the term of the contract, by observation; and by calibration; and by testing. The commissioning shall ensure the electrical systems perform interactively and correctly, according to the contract and operational requirements.
2. Commissioning shall provide startup, testing and documented confirmation of the contract constructed systems, materials and work, functions in compliance within the criteria set forth in the Contract Documents to the satisfaction of the District's needs. The commissioning scope shall encompass each system identified as requiring "commissioning" by the Contract Documents, including but not limited to:
   a. Electrical circuits' protection, short circuit, overcurrent, and ground fault devices.
   b. Electrical circuits monitoring and metering.
   c. Light fixtures, lamps and ballasts.
   d. Lighting control devices, equipment and lighting control systems.
   e. Standby and emergency electric power supply equipment and systems.
   f. Fire alarm, equipment, devices and fire alarm systems.
   g. Additional systems described in the contract documents.

3. Commissioning process shall review all of the shop drawing submittals, including:
   a. Controls, operation and maintenance requirements.
   b. Facility performance testing compliance.
   c. Project contract requirements compliance.
   d. Compliance with basis for design and operational descriptions provided in the contract.
4. Commissioning shall be the process of ensuring all the systems described in the Contract Documents comply with the Contract Document design; all systems are installed properly; all systems are functional, tested and capable of being operated and maintained to perform within the contract requirements and design intent.
5. Functional setup, recalibration, correcting deficiencies, retesting and the associated costs, for system(s) that fail commissioning, shall be the responsibility of the CONTRACTOR. The CONTRACTOR shall include all commissioning costs in the contract scope of work.
6. Complete all commissioning functions prior to the occupancy of the facility by the District, unless directed otherwise by the District's Representative.
7. Submit three (3) copies of commissioning documentation to District's Representative.
8. Commissioning, unless specifically indicated otherwise, shall be performed by factory-trained technician(s) authorized and certified by the Manufacturers of the respective equipment/systems. Where specifically indicated, commissioning shall be performed by Independent Test Lab.

B. Commissioning Procedures
1. Prepare a commissioning matrix identifying components and systems included in the commissioning scope; the status; actions completed and actions to be completed.
2. Verify CONTRACTOR compliance with Contract Document requirements manufacturer's recommendations and approved shop drawings.
3. Perform startup, functional tests, reports, and document results.
4. Evaluate and document the setup parameters, software, operating condition and performance of each system at the time of functional test completion. Document and record each performance parameter and condition, in the commissioning report.
5. Schedule testing and prepare descriptions of testing.
6. Describe measures performed to correct deficiencies.
7. Verify that instructions to District's Representatives, Operations and maintenance manuals comply with Contract Documents.
8. Prepare warranty matrix identifying the start dates, expiration dates, routine preventative maintenance dates and the District's responsibility for performing preventative maintenance and keeping logs for each maintenance function and warranty claims.
9. Confirm completion of all punch list items that have been acceptably accomplished and a list of what has not been acceptably completed.
10. Describe uncorrected deficiencies accepted by the DISTRICT.

C. Commissioning Phasing

The commissioning phases of work shall include the following activities:
1. SDQ - Shop Drawing Qualification shall verify complete and correct shop drawings have been submitted.
2. IQ – The Installation Qualification of contract work shall verify systems are correctly and properly installed.
3. OQ - Verify systems interfaces and software are correctly and properly operational.
4. ITM - Verify the contract Inspection, Testing and procedures for Maintenance are complete.
5. PQ - Performance Qualification complete the functional performance testing to validate each building system.

1.15 POWER OUTAGES

A. All electrical services in all occupied facilities of the contract work are to remain operational during the entire contract period. Any interruption of the electrical services for the performance of this work shall be at the convenience of the District and performed only after consultation with the District's Representative. Work involving circuit outages shall be only at such a time and of such a duration as approved in writing. Work involving circuit outages for the work required to connect new equipment and disconnect existing equipment shall be performed at the convenience of the DISTRICT Representative, with approval in writing.

B. Contract work involving outages or disruption of normal function in electrical power systems, telephone/communication systems, fire alarms, shall be performed during the following time periods. The contract work shall be phased to limit outages in the respective systems to the stated periods:
   1. 11:30 p.m. Friday to 11:30 p.m. Sunday of the same weekend. Work shall occur on multiple weekend periods if a single weekend is not sufficient time to complete the work.
   2. The contract work involving outages shall be phased in multiple work time units, to comply with the permitted outage limitations.

C. Work involving system outages to the building fire alarm system shall be performed only after consultation with the DISTRICT and shall be only at such a time and of such duration as approved in writing. Contractor shall provide continuous "Fire-Watch" during fire alarm system outages and comply with AHJ "Fire-Watch" requirements.

D. Provide overtime work; double shift work; night time work; Saturday, Sunday, and holiday work to meet outages schedule.

E. Provide temporary electrical power to meet the requirements of this Article.

F. Any added costs to CONTRACTOR due to necessity of complying with this Article shall be included in the Contract Scope of Work.

G. When electrical work involving power disruptions to existing areas is initiated, the work shall proceed on a continuous basis without stopping until electric power is restored to the affected areas.

H. The CONTRACTOR shall request in writing to the DISTRICT'S Representative a minimum of 3-weeks in advance, for any proposed electrical outage.

1.16 TEMPORARY ELECTRICAL POWER

A. Provide temporary electrical power if work requiring power outages cannot be completed in time permitted and approved by the DISTRICT'S Representative.

B. Temporary electrical power shall be a standby diesel engine generators. Voltage, frequency, regulation, etc. shall be equal to that of normal utility source. Exhaust system shall have a critical silencing muffler. Generator voltage shall match the existing secondary voltage required at the site. The CONTRACTOR shall furnish all necessary cables, switches, etc., to make all required

   Connections to existing panels, feeders, etc. Generator shall be sized to adequately carry the demand load. If record of demand load is not available, size generator to match corresponding transformer, maximum capacity circuit as directed by the District's Representative.

C. After completion of required usage of the temporary generators, prior to completion of the project, the CONTRACTOR shall remove the generators. All temporary cables, switches, etc. shall be removed and all permanent equipment left in satisfactory condition.

D. Each generator shall be housed in security type sound attenuated housing to prevent access by unauthorized personnel. Temporary power cables, connections, etc. shall be protected from unauthorized personnel.

E. The CONTRACTOR shall be responsible for complete operation of the generator including personnel, fuel supplies, proper safety precautions, etc. Generator shall not be left unattended while in operation.

F. The CONTRACTOR shall provide temporary construction lighting and power as required in areas where work is being performed. Temporary power arrangements, outages, installation, work schedules, etc., shall be submitted in writing 3-weeks prior to requested outage date, and approved by the DISTRICT'S Representative prior to start of work.

1.17 ASBESTOS, POLYCHLORINATED BIPHENYL (PCB) OR HAZARDOUS WASTE:

A. It is understood and agreed that this contract does not contemplate the handling of asbestos, PCB or any hazardous waste material. If asbestos, PCB or any hazardous waste material is encountered, notify the District's Representative immediately. Do not disturb, handle or attempt to remove.

B. Lighting Fixture Demolition Hazardous Materials
   1. The removal of existing lighting fixtures will generate hazardous material waste disposal contract documents.
      a. The existing lighting fixture ballast contains PCB material.
      b. The existing lighting fixture lamps contain mercury.
      c. The existing lighting fixture internal wire insulation may contain asbestos.
   2. Remove, handle, store, contain, dispose of and document the hazardous materials resulting from existing lighting fixtures work, as part of the contract requirements.

1.18 TIME/CURRENT COORDINATION, SHORT CIRCUIT, ARC-FLASH AND SERIES RATED EQUIPMENT

A. Series rated equipment.
   1. Circuit protective Devices identified as "Series Rated" or "Current Limiting" (i.e., CLCB - current limiting circuit breaker; CLF - current limiting fuse, etc.) shall be series rated and tested (UL 489 and CSA5) by the manufacturer with all equipment and circuit protective devices installed down stream of the identified series rated or current limiting device.
   2. Provide nameplates on all equipment located down stream, including the CLCB and CLF devices, to comply with CEC/NEC paragraphs 110-22 and 240-83 "CAUTION SERIES RATED SYSTEM - NEW DEVICE INSTALLATIONS AND REPLACEMENTS SHALL BE THE SAME MANUFACTURER AND MODELS".

B. Short circuit, coordination and ARC-Flash
   1. Perform engineering analysis and submit engineered settings for each equipment location, fuse and circuit breaker device, showing the correct time and current settings to provide the selective coordination within the limits of the specified equipment. Shall comply with the latest application standards of IEEE and ANSI. Provide electrical system short circuit worst case bolted-fault analysis, both 3-phase line-to-line and 1-phase line-to-ground calculations as part of the coordination analysis recommendations. Provide Electric ARC-FLASH calculations as part of the coordination analysis recommendations.
   2. The information shall be submitted in both tabular form and on time current log-log graph paper, with an engineering narrative. Written narrative describing data, assumptions, analysis of results and prioritized recommendations, six (6) copies.

3. The goal is to minimize an unexpected but necessary electrical system outage and personnel exposure to the smallest extent possible within the fault occurrence location, using the specified contract equipment. Shall comply with, but not limited to:

    a. IEEE-242, Recommended Practices for Protection and Coordination of Industrial and Commercial Distribution.
    b. IEEE-399, Recommended Practices for Industrial and Commercial Power System Analysis.
    c. IEEE-1584, Guide to Performing ARC-FLASH Hazard Study.
    d. CEC/NEC
4. Provide permanent warning labels on each equipment location. The labels shall describe ARC-FLASH, Short-Circuit and Time/Current Coordination, including safety precautions and protective clothing. Also described actions to be taken if any circuit changes or equipment modifications occur.
5. Shall be submitted with the shop drawing submittals for the respective equipment.

1.19 INDEPENDENT TESTING LABORATORY

A. Testing Laboratories Definition
    1. The Testing Laboratory shall meet Federal OSHA criteria for accreditation of Nationally Recognized Testing Laboratories (NRTL) Title 29 Part 1907 and 29 CFR-1910.
    2. Membership in the National Electrical Testing Association (NETA) shall also constitute acceptance of meeting said criteria, for testing of electrical systems.

1.20 SPARE FUSES

Provide three (3) spare fuses [for each size and type] [at each location] to match the installed fuses where the fuses are provided as part of the Contract. Provide spare fuse holders on inside door of each respective fuse compartment. Provide engraved nameplate on front of fuse access door indicating fuse type/catalog number ampere rating and manufacturer of fuse.

1.21 EQUIPMENT SEISMIC AND WIND LOAD REQUIREMENTS (ADDITIONAL REQUIREMENTS)

A. Seismic Performance and Seismic Restraint Requirements
    1. Shall be based on the following:
        a. Soils Site Class: ***
        b. Design Spectral Response Acceleration: ***
        c. Seismic Design Category: ***
        d. Building Component Importance Factor: ***
        e. Building Occupancy Category: ***
        f. Mapped Spectral Accelerations: ***
        g. Damped Design Spectral Response Accelerations: ***]
    2. Refer to Structural, Architectural, and Soils report contract documents for additional requirements.

B. General
    1. Equipment supports and anchorage's provided as part of the contract shall be designed, constructed and installed in accordance with the earthquake regulations of the California Building Code (CBC), International Building Code (IBC).
    2. Provide equipment anchorage details, coordinated with the equipment mounting provision, prepared, signed and "stamped" with PE registration in good standing, by a Civil or Structural Engineer licensed as a Professional Engineer (PE) in the State of California.
    3. Mounting recommendations shall be provided by the manufacturer based upon approved shake-table tests used to verify the seismic design of that type of equipment.
    4. The equipment manufacturer shall document the details necessary for proper wind-load and seismic mounting, anchorage, and bracing of the equipment for floor, ceiling, and wall/ back installation location.

5. Seismic performance shall be based on actual install location of the respective equipment in the building and height above or below grade.
6. The seismic requirements are typical for each equipment item exceeding 19-pounds, including but not limited to the following:
    a. Switchgear, switchboards, and motor control equipment
    b. Transformers
    c. Equipment racks and terminal cabinets
    d. Panels
    e. Conduits with floor, ceiling or wall attachment support and conduits with suspension attachments.
    f. Busway, wire way and cable tray
    g. Uninterruptable power supplies (UPS)
    h. Inverters
    i. Generators and related equipment
    j. Lighting equipment
    k. Fire alarm equipment

C. Certification
1. Electrical equipment manufacturers and Contractor shall provide Special Seismic Certification (SCC) for each specific equipment configuration with shake-table verification, all furnished as part of the contract documents requirements. The SCC shall include the specific installation location characteristics of the respective equipment including as follows:
    a. Ground or floor attachment
    b. Wall attachment
    c. Ceiling attachment
    d. Roof attachment
2. Wind Loading
    Electrical equipment and anchorages shall withstand the wind-load imposed at the install location. Wind loading withstand requirements shall apply to all electrical equipment installed in outdoor locations and to all electrical equipment exposed to the weather. The equipment shall be tested and certified by the manufacturer and Contractor. The wind-load withstand qualification of the equipment and anchorages shall be verified by the following methods:
    a. Areo-dynamic wind tunnel test method.
    b. Analytical calculation method, for oversized equipment too large for wind tunnel test method.
3. The wind-load withstand rating and the SCC shall comply with the requirements of the Authority Having Jurisdiction (AHJ), and include the latest revisions, but not limited to the following:
    a. American Society of Civil Engineers; ASCE-7
    b. CBC/IBC; including but not limited to Sections 1702, 1708, 1709, 1708A and 1709A.
    c. California Office of Statewide Health Planning and Development OSHPD; OPA-Preapproval of Anchorage; Code Application Notice CAN 2-1708A.5 and OSP-Special Seismic Certification Approval
    d. US Department of Homeland Security; FEMA- (installing seismic restraints for electrical equipment)

D. Wall Mounted Electrical Equipment
1. Surface Mounted Equipment
    a. Provide multiple horizontal sections of metal “C” channels for support and attaching wall mounted equipment to walls. Channels shall provide “turned lips” at longitudinal edges to hold “lock-in” fasteners and shall comply with ANSI-1008 and ASTM-A569 latest revision. The channels shall be steel hot dip zinc galvanized. As manufactured by Unistrut or Kindorf.

b. The “C” channels shall be positioned horizontally within 3-inches of the top and bottom of each, equipment section cabinet and located behind each equipment vertical section. Provide additional intermediate “C” channels at not less than 36-inches on center between the “top” and “bottom” “C” channel positions, located behind each equipment vertical section.
c. The “C” channels shall be of sufficient length to provide connection to not less than two (2) vertical structural wall framing elements separated by not less than 16-inches; but in no case shall the “C” channel length be less than the width of the respective equipment section.
d. Attach the “C” channels to the wall structural elements after the wall, finish surface, installation (including painting) is complete.
e. Attach the “C” channels with fasteners to the building wall framing structural elements as follows: welded to steel framing; bolted to wood framing; cast in place concrete inserts for masonry and concrete construction; drilled “afterset” expansion anchors for existing masonry and concrete construction.
f. Attach the equipment to the “C” channels with threaded and bolted fasteners to “pre-locate” and lock into the channel “turned lips” and channel walls.

2. Flush mount equipment
   a. Provide anchor attachment of equipment into adjacent wall structural elements.

E. Housekeeping Pad
1. Provide cast-in-place, steel re-enforced concrete raised “housekeeping” pads under all floor standing electrical equipment (except data network equipment racks).
2. Pad sizes
   a. The raised housekeeping pad height shall extend 4-inches above the surrounding finished floor elevation for interior building locations.
   b. The pad shall extend 8-inches below finish grade plus 4-inches above finish grade for outdoor equipment location on grade.
   c. The pads shall extend 7-inches past the “footprint” edge of the respective floor standing equipment.
3. Anchor equipment to pads. Anchor pads to the building structural floor. Equipment pad, equipment re-enforcing and equipment anchoring shall comply with seismic earthquake requirements and wind load requirements.
4. Unless shown otherwise on drawings. The equipment housekeeping pad steel re-enforcing shall consist of two (2) layers of number 4-size steel-rebar laid horizontally and uniformly spaced 6-inches on center. Position rebar in two (2) directions (90-degrees opposed) and centered inside the concrete house keeping pad. Horizontal rebar shall extend to within 3-inches of the edge of the concrete pad in all directions. Metal wire “tie-wrap” shall be provided at each rebar crossing.
5. Equipment anchor attachments shall extend through the housekeeping pad and into the structural concrete below the pad a minimum of not less than 2-inches.

1.22 ELECTRICAL WORK CLOSEOUT

A. Prepare the following items and submit to the District’s Representative before final acceptance.
1. Two (2) copies of all test results as required under this section.
2. Two (2) copies of local and/or state code enforcing authorities final inspection certificates.
3. Copies of record drawings as required under the General Conditions, pertinent Division One Sections and Electrical General Provisions.
4. Two (2) copies of all receipts transferring portable or detachable parts to the DISTRICT’S Representative when requested.
5. Notify the District’s Representative in writing when installation is complete and that a final inspection of this work can be performed. In the event any defect or deficiencies are found during this final inspection they shall be corrected to the satisfaction of the District’s Representative before final acceptance can be issued.
6. List of spare fuses and locations identified by equipment name and building designation.

7. Prior to energizing, retighten to the proper torque, each circuit conductor lug landing, each bus bar (phases, neutral and ground) and circuit protection device threaded connections in all switchboards, switchgear, motor control centers, transformers, busways, disconnect switches, motor starters, motor terminals and panelboards, after the equipment is installed/ connected and prior to energizing the equipment. The torque values shall comply with manufacturer's recommendations.

B. Electrical power single line diagrams – SLD
   1. Provide single line diagrams showing the contract document work complete electrical power system (normal and emergency). SLD shall show inter-connection circuits, electrical equipment, panels, and circuit protection devices, nominal 50% (½-size) approximately 18-inches by 24-inches. Show installed voltages and electrical capacity sizes.
   2. SLD shall be mounted in metal (picture frame) rigid enclosure frame with rigid-backing (backer-board) and clear/transparent front, for hanging on wall. Provide clear transparent cover over SLD inside the frame.
   3. Provide a wall-hung (48-inches) SLD in each “main” and “sub” electrical equipment room. If wall space is limited, alternatively securely attach SLD frame to room door facing into the respective electrical room.

END OF SECTION

SECTION 26 05 15

BASIC ELECTRICAL MATERIALS AND METHODS

PART1 GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other sections for work related to those other sections and required to be included as work under this section.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS}

A. Submit product data sheets for all outlet boxes, floor boxes, wiring devices, device plates, relays, contactors, timeswitches, and disconnects fuses.

B. Submit detailed shop drawings including dimensioned plans, elevations, details, schematic and point-to-point wiring diagrams and descriptive literature for all component parts for transformers, relays, time clocks, and photocells.

C. Submit transformer test reports.

D. Submit material list for outlet boxes.

PART 2 PRODUCTS

2.01 OUTLET AND JUNCTION BOXES

A. General
   1. Flush or concealed outlet and junction boxes: Pressed steel, steel thickness not less than 0.062-inch, hot-dip galvanized, knockout (KO) type with conduit entrances and quantities size to match conduits shown connecting to respective outlet box. U.L.-514 listed and labeled. Minimum required box depth is exclusive of extension-ring depth.
   2. Provide boxes of proper code size for the number of wires or conduits passing through or terminating therein, but in no case shall box be less than 4.0 inch square by 2.125 inch deep, unless specified elsewhere or noted otherwise on the drawings. 2.5 inch minimum depth for box widths exceeding 2-gang.
   3. Increase the minimum outlet box size to 4.69 inches square by not less than 2.125 inches deep, where one or more of the following conditions occurs:
      a. More than two (2) conduits connect to the outlet box.
      b. Conduit "homerun" connects to outlet box.
   4. Provide extension rings on flush outlets to finish face of extension ring flush with finished building surfaces. Extension ring shall match outlet box construction and contain "attachment mounting-tabs" for wiring devices. Extension rings shall be "screw-attached" to respective outlet box and maintain "ground" bonding continuity.
   5. Boxes installed in masonry or concrete shall be U.L. "concrete-tight" approved for installation in concrete, and shall allow the placing of conduit without displacing reinforcing bars.
   6. Provide fixture-supporting device in outlet boxes for surface mounted fixtures as required.
   7. Provide solid gang boxes for three or more switches, for mounting behind a common device plate.
   8. Provide barriers for all 277 volt devices, between line voltage and low voltage devices and where more than one device is installed in an outlet box.

9. Individual audio/visual, telephone, computer or data outlets: 4.69 inch square by 2.125 inch deep minimum with two gang extension ring on flush boxes.
10. Combination signal/telephone/data or computer outlets: 4.69 inch square by 2.125 inch deep minimum with 2-gang wide extension ring on flush boxes.

B. Surface Outlet Boxes
1. Surface mounted outlet boxes, cast iron Type FS or FD, with threaded hubs as required. Box interior dimensions and interior volume capacity not less than required for "press steel boxes", and "sheet steel boxes". Provide plugs in all unused openings. Provide vyeatherproof gaskets for all exterior boxes.

C. Floor Boxes and Outlets
1. Recessed Combination Power/Signal Floor Box
a. Floor box shall be cast iron, UL listed for concrete installation with leveling screws. Walker "Resource" RFB4-CI Series or equal.
b. Floor box shall be listed for thru wiring.
c. Floor box shall contain four independent, barriered wiring compartments.
d. Overall dimensions shall not exceed 14 1/2" long x 11" 7/8" wide x 3 1/2" deep.
e. Box cover shall be flush with floor and shall provide wire/cable egress points through cover notches. The trim and cover shall be of metal composition. Covers shall be hinged. Walker RAKMTR-BUFF Series or equal.
f. Unit shall include two duplex receptacles as herein specified and two signal system outlets. Walker CIHT-D and CILT-2T.
g. Activation assemblies shall include device mounting brackets, access plates, grommets, partitions, adjusting rings and all associated hardware.

2.02 PULL BOXES

A. Sizes as indicated on the drawings and in no case of less size or material thickness than required by the governing code. Exercise care in locating underground pull boxes to avoid installation in drain water flow areas.
1. General purpose sheet steel pull boxes: Install only in dry protected locations with removable screw covers. Manufacturer's standard baked enamel finishes.
2. Weatherproof sheet steel pull boxes: Fabricate of code gauge, hot-dip galvanized steel with gasketed weathertight cover of same material. Manufacturer's standard baked exterior enamel finish.

2.03 SWITCHES

A. Provide circuit switches totally enclosed, Bakelite or composition base, toggle type with 277 volt A.C. rating for full capacity or contacts for incandescent or fluorescent lamp loads. Switch ratings shall be 20 ampere only. Color as selected by OWNER'S REPRESENTATIVE. Switches controlling circuits connected to emergency power shall be red.

B. Where switches are mounted in multiple gang assembly and are operating at 277 volts and/or 277 volts and 120 volts mounted in same outlet box, there shall be a barrier installed between each switch.

C. Switches – Specification Grade Commercial Series
1. Single Pole Switches

	Toggle Type	Lock Type
Make	20 Amps	20Amps
Hubbell	#CS1221	#CS1221-L

2. Double Pole Switch

Hubbell	#CS1222	#CS1222-L

3. Three-Way Switches

Hubbell	#CS1223	#CS1223

4. Four-Way Switches

Hubbell	#CS1224	#CS1224-L

5. Momentary Contact Switches- 20A at 277V

	3'-Position Req.	3-Position Lock
Hubbell	#1557	#1557-L

6. Maintained Contact Switches (Double Throw, Center Off), 20A at 277V

	Toggle Type		Lock Type	
Make	1-Pole	2-Pole	1-Pole	2-Pole
Hubbell	#1385	#1386-L	#1385-L	#1226-L

7. Ground Fault Circuit Interrupter (GFCI)
   Hubbell GFST15I, or GFST20I

8. Pilot lights used in conjunction with circuit switches shall be neon type with red jewel, P & S #437 (120 volt) or #438 (277 volt) or approved equal.

2.04 DIMMER SWITCHES

A. Dimmer switches shall be as indicated herein unless specifically noted otherwise on the drawings.

B. Dimmer cover plate shall be the same color as switch cover plates in the same area.

C. Dimmer switches shall be self-cooling and shall not require forced air cooling when individually or gang mounted. All dimmers shall be by the same manufacturer and the same appearance.

D. Dimmers shall include "RF" filters and is voltage stabilized.

E. Incandescent dimmers shall be used for control of line voltage incandescent light fixtures except "low voltage" type lights. Lutron "Centurion" series.
   1. Dimmer wattage shall be rated 2000 watt unless noted otherwise on the drawings.

F. Fluorescent dimmers, voltages as indicated on the drawings.
   1. Fluorescent dimmers (individual dimmers controlling less than 24 lamps per dimmer) Lutron "Nova" series.
   2. Fluorescent dimmers (more than 24 lamps)
      a. Lutron #FDA-40 up to 40 lamps per controller.
      b. Lutron #FDA-80 up to 80 lamps per controller.
      c. Provide a minimum of 3-20 amp on all 120 volt units and on 277V 80 amp units.
      d. Control stations Lutron "Nova" series.
      e. Provide all material and labor for a complete and operable system.

G. Low voltage (transformer type) incandescent light dimmers shall be specifically designed for dimming low voltage light fixture transformers. Lutron "Nova".

2.05 RECEPTACLES

A. All receptacles in flush type outlet boxes shall be installed with a bonding jumper to connect the box to the receptacle ground terminal. Grounding through the receptacle mounting straps is not acceptable. The bonding jumper shall be sized in accordance with the branch circuit protective device as tabulated herein under "Grounding". Bonding jumper shall be attached at each outlet to the back of the box using drilled and tapped holes and washer head screws 6-32 or larger (except isolated ground receptacles). For receptacles in surface mounted outlet boxes direct metal-to-metal contact between receptacle mounting strap (if it is connected to the grounding contacts) and outlet box may be used. Color as selected by OWNER'S REPRESENTATIVE. Receptacles connected to emergency power circuits shall be red.

B. Duplex convenience receptacles shall be grounding type, 120 volt, 15 ampere, and shall have two current carrying contacts and one grounding contact which is internally connected to the frame. Outlet shall accommodate standard parallel blade cap and shall be side wired:
   1. Hubbell, Specification Grade Commercial Series, Ivory, or equal.

C. Isolated ground receptacles
   1. The receptacle insulation barrier shall isolate the receptacle ground contact system from ground. Connect the ground plug contact to a separate dedicated insulated ground-bonding conductor. The receptacle ground plug contact shall not be grounded to the raceway or outlet box. Duplex convenience receptacle 20 amp minimum, with two current carrying contacts and one grounding contact, or as noted on the drawings.
   2. Identify receptacle with an orange triangle on the receptacle face and orange receptacle body. Red body for receptacles connected to emergency power.
      a. Hubbell, Specification Grade Commercial Series, Ivory, or equal.

D. Weatherproof receptacle: Ground fault type duplex receptacle, mounted in a flush hinged door enclosure with lock and key. Enclosure shall be a P & S #4600 with a #1591F46 receptacle. On exposed conduit runs, weatherproof ground fault type receptacle as hereinbefore specified, installed in "FS" condulet with one of the following spring door type covers:
   1. Hubbell, Specification Grade Commercial Series, or equal.

E. Special outlets shall be as indicated on the drawings.

2.06 PLATES

Provide plates for every switch, receptacle, telephone, computer, television and other device outlets. All plates shall be 0.040" stainless steel, Type 302 alloy composed of 18% chromium and 8% nickel. Plates shall be manufactured by P & S, Hubbell, Leviton or General Electric only.

2.07 VANDALPROOF FASTENINGS

Provide approved vandalproof type screws, bolts, nuts where exposed to sight throughout the project. Screws for such items as switch plates, receptacle plates, fixtures, communications equipment, fire alarm, blank covers, wall and ceiling plates to be spanner head stainless steel, tamperproof type. Provide OWNER with six (6) screwdrivers for this type.

2.08 STRUCTURAL AND MISCELLANEOUS STEEL

Structural and miscellaneous steel used in connection with electrical work and located out-of-doors or in damp locations, to be hot-dip galvanized unless otherwise specified. Included are underground pull box covers and similar electrical items. Galvanizing averages 2.0 ounce per square foot and conforms to ASTM A123.

2.09 FLASHING ASSEMBLIES

Provide Semco Fig. #1100-4 lead flashing assemblies at all roof penetrations. Seal the joint between flashing and pipe with waterproofing compound.

2.10 RELAYS, CONTACTORS, AND TIMESWITCHES

A. Individual Control Relays (HV/AC Plumbing of the Control Functions)

1. Individual control relays shall have convertible contacts rated a minimum of 10 amperes, 600 volts regardless of usage voltage. Coil voltage, number and type of contacts shall be verified and supplied to suit the specific usage as shown in the wiring diagrams and/or schedules on the electrical and mechanical drawings. Coil control circuit shall be independently fused, sized to protect coil. Relays shall be installed on prefabricated mounting strips. Each relay shall have a surge suppressor to limit coil transient voltages. Furnished in the NEMA Type I enclosure unless indicated otherwise.
2. The following relays are approved:

Manufacturer	IYQg
Arrow Hart	IMP
General Electric	Class CR 2811
I.T.E.	Class J10
Square D Co.	Class 8501, Type A
Westinghouse	Bul. 16-321, Type NH
Allen Bradley	Approved Equal

B. Contactors and/or Relays

1. Contactors and/or relays for control of lighting shall be 600 volt A.C., electrically operated, mechanically held units, open type for panel mounting with number of poles and of size as indicated on the drawings. Provide auxiliary control relay for operation of each contactor and/or relay with a two-wire control circuit.
2. Contactors and/or relays shall be mounted in panelboards in barriered section under separate hinged lockable doors or in contactor and/or relay cabinets as called for on the drawings. Contactors and/or relays shall be installed on Lord sound absorbing rubber mounts.
3. Contactors and/or relays shall be Automatic Switch Co. Bulletin #920 Series for 2 and 3 pole, Automatic Switch Co. Bulletin 917 Series with poles as indicated on drawings. Coil control circuit shall be independently fused, sized to protect coil.
4. Contactors and/or relays shall be equipped with a switch, in the proper configuration, to disconnect the control circuit controlling 'the coil of the respective device. Control circuit disconnect switch shall be labeled showing function of device.

C. Timeswitches

1. All timeswitches shall have synchronous motor drive for operation on 120 or 277 volts, 60 Hertz, A.C. and shall be furnished with a ten-hour, spring-driven, reserve-power motor. Contacts shall be rated 40A per pole.
   a. Exterior lighting timeswitches for control of individual circuits or electrically operated relays shall have astronomic dial and shall be Tork 7000ZL Series or approved equal by Paragon or Intermatic.
   b. Interior lighting timeswitches for control of individual circuits or electrically operated relays shall be Tork 7000 Series or approved equal by Paragon or Intermatic.

c. Timeswitches for control of air conditioning or plumbing equipment shall have seven day dial and shall be Tork WL Series or approved equal by Paragon or Intermatic.

2. All timeswitches shall be mounted in separate section in top of panelboards under separate lockable door unless otherwise indicated on drawings. Clear opening for timeswitch shall be a minimum of 12" x 12".

D. Contactors and/or Relays/Timeswitch Cabinet

1. Contactors, relays, and/or timeswitches not indicated to be mounted in electrical panels shall be mounted in a cabinet, size as required, with hinged lockable door keyed same as panelboards. Construction of cabinet shall be similar to terminal cabinets.
2. Each contactor, relay or timeswitch mounted in the contactor cabinet shall be barriered in its own compartment, and shall be installed on Lord sound absorbing mounts.
3. Contactor cabinets shall be of the same manufacturer as the panelboards.
4. Where relays and/or contactors occupy the same enclosure as timeswitches they shall have a clear acrylic shield installed over each relay or contactor to guard line exposed parts from accidental contact by nonauthorized personnel.

2.11 DISCONNECTS (SAFETY SWITCHES)

Disconnect switches shall be rated 600 volt A.C., NEMA Type HD, quick-make, quick-break, h.p.-rated, fused Class "R", in NEMA Type **I** enclosure, lockable with number of poles and amperage as indicated on the drawings. Provide neutral bus and conductor landing lugs, size to match conductors shown on drawings. Where enclosure is indicated W.P. (weatherproof) switches shall be raintight NEMA Type 3R enclosure, lockable. Maximum voltage, current and horsepower rating clearly marked on the switch enclosure and switches having dual element fuses shall have rating indicated on the nameplate.

2.12 TRANSIENT VOLTAGE SURGE PROTECTOR (TVSS)

A. General

1. The unit shall be modular in construction and operate in parallel with 60 H.Z. A.C. line voltage, four (4) wire or five (5) wire, grounded or ungrounded systems, as applicable; voltage, KVA and ampere capacity as indicated on the drawings. Suitable for connection through a external circuit breaker or combination switch/fuse protective device rated 30 ampere, continuous duty, rated for Service Entrance equipment connection.
2. The unit shall operate correctly with any combination of resistive, inductive, or capacitive loads. The unit shall automatically shunt to ground the electrical transients and EMI/RFI noise occurring above the specified values. The unit shall automatically reset after transient condition has passed. Operating temperature - 40° centigrade to 85° centigrade.
3. Provide one or more individual self-contained protection module(s) for each line voltage phase, plug-in type. Provide one spare individual plug-in protection module. Provide incoming line, neutral and ground conductor termination lugs rated CU/AL #14 thru #4 AWG. Lugs shall be barriered from and prewired to the respective protection modules.
4. Provide a NEMA 12 housing to contain all unit modules, devices and conductor terminations. The housing shall include a hinged padlockable door. Surface mounted, with conduit entrance knockouts. Maximum housing size shall not exceed 36" wide x 72" high x 8" deep.
5. As manufactured by EFI Corporation Model #MXPB/TVSS; MCG Electronics; Current Technology; Liebert or equal.

B. Operational Characteristics

1. Transient voltage protection, testing, listing and certification.
   a. UL 1449 (latest edition) and CSA, for Transient Voltage Surge Suppresser, UL 1283 for transient voltage electrical noise attenuation, ANSI/IEEE C62.45, C62.1 for C62.41, (latest edition) transient clamping voltages for both Normal Mode and Common Modes against Category A & B ring wave and Category B impulse wave.

b. The unit connected to the service entrance shall also withstand a minimum of 1000 sequential ANSI/IEEE C62.41 Category C surges without failure following IEEE test procedures in C62.1, C62.41 and C62.45.

2. Transient voltage protection, EMI noise rejection, and RFI noise rejection shall be provided for Common Mode (line-to-neutral), Normal Mode (line-to-line) and neutral to ground.

3. EMI and RFI noise rejection.
   Conducted line noises interference both electromagnetic (EMI) and radio frequency (RFI) shall be reduced by the unit over a continuous spectrum of 0.5 MHZ to 1.0 MHZ. The basis for reduction shall be a standardized 50-0HM insertion loss MIL -STD-220A test. Provide spectrum analysis test dB attenuation reports showing RFI filtering over specified frequencies. Test data based on calculated or computer simulation is not acceptable.

4. Three phase and grounded 'WYE" performance requirements.

Characteristics	208/120 Volt	480/277 Volt
a. Nominal line to line	208 Volt	480 Volt
b. Nominal line to neutral	120 Volt	277 Volt
c. Internal capacitance (Microfarads)	2.5	2.5
d. Maximum response time	1-nanosecond	1-nanosecond
e. EMI/RFI noise rejection	25-35DB	25-35DB
f. Nominal peak clamp voltage line to neutral		
and line to ground	205 Volts	330 Volts
g. Minimum transient energy dissipation per phase		
(at 8 x 20 microseconds (waveform))	1000 Joules	1500 Joules
h. Peak transient withstand (at 8 X 20 microseconds waveform)		
without failure of the unit	50000 Amp	60000 Amp
1.Category-C3	80,000Amp	100,000Amp
2.Category-B3	60,000Amp	80,000Amp
3.Category-A3	50,000Amp	60,000Amp

C. Diagnostic indicators

1. Shall display the "Normal" and "Fault" status of each line suppression circuit, along with protection circuit "on" indication.
2. Shall provide a sonic audible fault alarm with silence push-button.

D. Surge Suppressor Protection Categories
1. Surge protectors shall comply with ANSI C62.41 (Latest Revision) Standard Protection Categories for "impulse" and "ringwave" transients, based on the installation locations shown in the contract documents.
   a. Service entrance, main switchboard or substation locations - Category "C3", high exposure.
   b. Mid building, distribution panels, distribution panels over 400 ampere main bus rating locations- Category "B3", high exposure.
   c. Branch circuit panelboards 400 ampere or less main bus rating - Category "A3", high exposure.
2. The TVSS short circuit current withstand rating shall exceed the actual short circuit current available at the TVSS installation location

2.13 WIREWAY

A. General
Unobstructed lay in type, metal wireway, fittings and connectors U.L. listed for use as wireway and auxiliary gutter. Length, elbows and "T-S" as shown on drawings. Minimum cross-section size 4 inches X 4 inches, but not less then shown on the drawings. Suitable for mounting in any position orientation.

B. Construction
1. Minimum metal gauge shall not be less then 14 gage.
2. Cover shall be hinged entire length of cover. Cover shall be held in the closed position with bolts and nuts.
3. Provide spring nuts on all hardware fastener penetrations into the interior of the wireway to protect against wire insulation damage.
4. The inside of 90-degree corners in the wireway shall be a 45-degree bevel.
5. Grounding continuity between wireway sections and fittings shall be continuous the entire length of the wireway.

C. Finish
1. Indoor non-raintight, rust inhibitor phosphatizing base coating and baked enamel finish, manufacturer's standard color.
2. Raintight or outdoor-galvanized metal, with corrosion resistant phosphate primer and baked enamel finish, manufacturer's standard color, Nema 3R construction.
3. All hardware shall be plated to prevent corrosion.

PART 3 EXECUTION

3.01 GROUNDING (ADDITIONAL REQUIREMENTS)

A. Grounding shall be executed in accordance with all applicable codes and regulations, both of the State of California, and local authorities having jurisdiction, and in compliance with DSA.

B. Each pull box or any other enclosure in which several ground wires are terminated shall be equipped with a ground bus secured to the interior of the enclosure. The bus shall have a separate lug for each ground conductor. No more than one conductor shall be installed per lug.

C. The maximum resistance to ground shall not exceed 5 ohms.

3.02 OUTLET AND JUNCTION BOXES

A. Accurately place boxes and securely fastens to structural members. Where outlets are shown at same location but at different mounting heights, install outlets in one vertical line. Where outlets are shown at same location and mounting height, mount outlets as close together in a

horizontal row as possible. Where the outlet boxes for switches and receptacles are shown at the same location and mounting height, mount in common outlet box with barriers between devices. Provide single piece multigang cover plate for close mounted outlet boxes. Where switches are shown on wall adjacent to hinge side of doors, box shall be installed to clear door when door is fully opened.

B. Flush mounted boxes shall be attached to two studs or structure members by means of metal supports.

C. Boxes above accessible ceilings shall be attached to structural members. Where boxes are suspended, they shall be supported independently of conduit system by means of hanger rods and/or preformed steel channels. Boxes shall be supported independently of all piping, ductwork, equipment, ceiling hanger wires and suspended ceiling grid system.

D. Surface mounted outlets shall be attached to concrete or masonry walls by means of expansion shields.

E. Floor boxes shall be installed level with finish floor and within adjustable limits of floor ring. Where outlets are shown at same or adjacent location, use multigang boxes.

F. Outlet Box Horizontal and Vertical Separation: Outlet boxes and device outlet rings installed flush in walls shall be horizontally and vertically separated by not less than 24 inches (edge of box to edge of box) from device outlet boxes and rings in common wall surfaces located on the opposite (back) side of the same wall.
   1. Where the separation cannot be maintained, provide a solid backing behind and completely enclosing each outlet box.
   2. The backing shall extend the width of the wall cavity (i.e. between "studs" or masonry cells) behind the box and 12 inches above and below the outlet box centerline, completely enclosing the outlet box.
   3. The backing shall consist of the following:
      a. 5/8 inch thick gypsum board anchored in place for "stud" wall construction.
      b. Solid "mortar" to completely fill the outlet box "cell" behind the box in masonry construction.

G. In fire rated walls and ceilings provide fire rated "box-wrap" around the outside of each outlet box placed in fire rated wall or ceiling inside the wall, to maintain the fire rating of wall with the installed outlet boxes.

H. Plug-in type receptacle installation orientation:
   1. The "ground-pin" shall face "up" at the receptacle top location {double duplex) 4-plex, individual and vertically mounted individual duplex receptacles.
   2. The "neutral-blade" shall face "up" at the receptacle top location on horizontally mounted duplex receptacles.

3.03 DIMMER SWITCHES

A. Do not break off dimmer cooling fins.

B. Large dimmers shall be surface wall mounted at the location indicated on the drawings.

3.04 TRANSIENT SURGE PROTECTOR INSTALLATION (TVSS)

A. Installation
   1. Install unit cabinet to insure a maximum connected circuit length of less than 8 feet from the equipment the transient surge unit is connected to, approximately +48" on wall.
   2. Install TVSS inside switchgear, switchboards, panelboards, etc. where shown on the drawings.
   3. Connect between transient surge unit and supply equipment with not less than 1 1/4" conduit containing 5#4 AWG, copper conductor, 600 volt THHN/THWN insulation, connection circuit.

B. Install, connect and test unit in accordance with manufacturer's recommendations.

C. Connect transient surge unit to main building ground bus with 1 1/4"C - 1#2 AWG copper conductor 600 volt, THHN/THWN insulation.

D. Provide a subfeed overcurrent protective device in the respective panel or switchboard to supply the TVSS connection circuit, whether or not shown on the drawings. The protective subfeed device shall be a thermal magnetic circuit breaker rated not less than 30 ampere - 3 pole or a safety switch and fuse unit rated not less than 60 ampere - 3 pole, voltage and short circuit interrupting class to match the respective circuit voltage.

3.06 WIREWAY INSTALLATION

Wireway hangers shall provide clamp type, hanger rod type, direct bolted bracket type from ceiling or walls as indicated on the drawings and required for field installation locations. Supports shall be installed a minimum of 5 ft. on center.

END OF SECTION

SECTION 26 05 30
CONDUIT AND WIRE

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other sections for work related to those other sections and required to be included as work under this section.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit product data sheets for all wire, supports, conduit, fittings and splicing materials.

B. Submit material list for all conduit and conduit fittings.

C. Submit details and structural engineering calculations for conduit support systems.

PART 2 - PRODUCTS

2.01 CONDUIT

A. General
   1. The interior surfaces of conduits and fittings shall be continuous and smooth, with a constant interior diameter. Conduits and conduit fittings shall provide conductor raceways of fully enclosed circular cross section. The interior surfaces of conduits and fittings shall be without ridges, burrs irregularities or obstructions. Conduits and fittings of the same type shall be of the same uniform weight and thickness.
   2. Type of conduit, type of conduit fittings and conduit supports shall be suitable for the conditions of use and the conditions of location of installation, based on the manufacturer's recommendations and based on applicable codes.
   3. All fittings for metal conduit shall be suitable for use as a grounding means, pursuant to the applicable code requirements. All metal conduit and metal conduit fittings shall provide 3 second duration ground fault current carrying ratings, when installed and connected to the respective conduit, as follows:
      a. RMC and EMT conduit fittings.
         1) 0.75 inch through 1.5 inch conduit/fitting size - 10,000 ampere RMS.
         2) 2.0 inch and larger conduit/fitting size - 20,000 ampere RMS.
      b. FMC and LTFMC Conduit Fittings
         1) 0.75 inch through 1.25-inch conduit/fitting size-1,000 ampere RMS (without external bonding jumper).
         2) 1.5 inch through 4.0-inch fitting size-10,000 ampere RMS with bonding jumper.
   4. Protective corrosion resistant finish for metal conduit fabricated from steel and metal conduit fittings fabricated from steel, shall be as follows:
      a. Clean all metal surfaces (including metal threads) with acid bath "pickle" prior to coating, to remove dirt, oil and prepare surfaces for galvanizing.
      b. Hot-dip galvanized zinc coating on all interior and exterior steel surfaces. Minimum finish zinc coating thickness shall not be less than 0.002 inches.

c. Threads shall be hot-dip zinc coated after machine fabrication.
d. Exterior metal surfaces shall be finished with clear organic polymer topcoat layer, after galvanizing.
e. The inner metal surfaces of conduit fittings shall be finished with a lubricating topcoat after galvanizing, to facilitate conductor pulling through the conduit/fitting.

5. Threads for metal conduit and metal conduit fittings shall be taper-pipe-thread, National Pipe Standards (NPS) and shall comply with ANSI-B1.20.1.
6. Metal conduit termination connector fittings shall be provided with a manufacturer installed, insulating throat bushing inside the fitting. The bushing shall protect the wire conductor insulation from cutting, nicks and abrasion during conductor installation and electrical load "cycling" after installation is complete. The bushing shall comply with UL 94V-0 flammability.
7. Provide conduit bonding/grounding jumper from metal enclosures with "concentric ring" knockouts, to positively ground/bond each respective conduit(s) to the metal enclosure.
8. Metal conduit fittings connecting to PVC coated metal conduit shall be PVC coated to match the conduit.
9. The conduit and fittings shall be watertight and airtight without cracks and pinholes.

B. Rigid Metal Conduit (RMC)
1. Rigid metal, round tubing, machine threaded at both ends.
   a. The conduit and conduit fittings shall comply with the requirements for an equipment grounding conductor, pursuant to applicable codes.
2. RMC raceway types shall be as follows:
   a. Rigid galvanized steel conduit (RGS), minimum yield strength shall be 35,000 PSI. Shall comply with NEMA standard 5-19 (latest revision); ANSI C80.1 and ANSI-C80.4 (latest revision); UL 514-B and UL 6 (latest revisions); National Pipe Standard Specification (latest revision).
   b. Intermediate steel conduit (IMC). Shall comply with NEMA Standard 5-19 (latest revision) ANSI-C80.6 (latest revision); UL 2142 (latest revision).
3. RMC fittings:
   a. Fittings shall be compatible with RGS and IMC.
   b. Fittings shall be rated "liquid tight".
   c. Fittings imbedded in concrete shall be rated "liquid tight" and "concrete tight".
   d. Connectors and couplings for terminating, connecting and coupling to RMC conduit shall be threaded metal.
   e. Fittings shall comply with ANSI C80.4 and ANSI C33-84 (latest revision); NEMA FB1 (latest revision); UL 514 (latest revision).
   f. Conduit seal fittings:
      1) Conduit seals shall prevent the passage of gasses, liquids and vapors past the location of the seal installation in the conduit.
      2) Conduit seals shall be suitable for installation in both vertical and horizontal conduit locations.
      3) Conduit seals shall be visible and accessible for inspection after installation is complete.
      4) Conduit seals shall be rated for the following locations:
         a) Wet locations
         b) Classified hazardous location materials NEC Class 1 Division 1.
         c) Temperature ranges from 0 [minus 20] degrees centigrade through 90 degrees centigrade.
      5) Conduit seals, sealing compound and sealing compound dam shall be the products of the same manufacturer.
4. RMC fittings as manufactured by:
   a. For threaded enclosure, termination connection.
      1) Thomas & Betts - 106 Series bonding locknut, 5302 series sealing ring with stainless steel retainer.
   b. For non-threaded enclosure, termination connector.

1) Thomas & Betts - 370 Series watertight threaded sealing hub, 106 series threaded bonding lock nut, Sta-Con Series enclosure bonding jumper and 3870 Series threaded ground bushing.
2) Emerson-OZ/Gedney-CHMT/CHT watertight threaded hub with bonding locknut and GH50G Series enclosure bonding jumper.

c. For RMC to RMC conduit-to-conduit coupling
1) Thomas & Betts/Erickson - 674 (threaded) Series
2) Emerson-OZ/Gedney Type TPC (threaded) Series
3) Threaded RMC conduit couplings, product of the same manufacturer as the RMC conduit.

d. For RMC Conduit Seals
1) Emerson-OZ/Gedney-EYA and EYAM (threaded) Series
2) Appleton-EYF and EYM (threaded) Series

C. Electrical Metallic Tubing (EMT)

1. Rigid metal round tubing, "thin wall" steel construction, with non-threaded ends.
a. The conduit and conduit fittings shall comply with the requirements for an equipment grounding conductor pursuant to applicable codes.
b. The conduit shall be watertight and airtight without cracks and pinholes.

2. EMT shall be allowed for conduit size ranges from 0.75-inch through 2.0-inch. EMT is not allowedfor exterior locations, including under covered walks, shelters, or roof overhangs. EMT is not allowed less than ten (10) feet above FF, not in concrete, not underground, and not in runs longer than 100'.

3. Comply with ANSI C80.3, C80.4, and ANSI C33.98 (latest revisions); UL 594 and UL 797 (latest revisions); CEC Section 12500 (latest revision).

4. EMT fittings:
a. Connectors and couplings for terminating, connecting and coupling to EMT conduit shall be non-threaded steel fabrication.
b. EMT termination connector fittings shall be as follows:
1) Set screw type "concrete tight" when installed in dry interior locations.
2) Compression types "raintight" and "concrete tight" when installed in wet or damp locations, outdoors and in concrete or masonry construction.
c. Fittings shall comply with ANSI C33.84 (latest revision); UL 514 (latest revision); NEMA FB-1.

5. EMT fittings as manufactured by:
a. For threaded and non threaded enclosure, termination connector
1) Thomas & Betts-TC721A (set screw type) Series (with locknuts).
2) Emerson-OZ/Gedney-TC500I (set screw type) Series (with locknuts).
3) Thomas & Betts-5123 (compression type) Series (with 2 locknuts).
4) Emerson-OZ/Gedney-TC600I (compression type) Series (with locknut).
5) Thomas & Betts-4240 (compression type) Series (90 degree angle with locknut).
6) Emerson-OZ/Gedney-TWL (compression type) Series (90 degree angle with locknut).
b. For EMT to EMT conduit-to-conduit coupling:
1) Thomas & Betts-TK121A (set screw type) Series (with locknut).
2) Emerson-OZ/Gedney-5000 (set screw type) Series (with locknut).
3) Thomas & Betts-5120 (compression type) Series.
4) Emerson-OZ/Gedney-TC600 (compression type) Series.
c. For EMT to RMC conduit to conduit combination coupling:
1) Thomas & Betts-HT221 (set screw type) Series.
2) Emerson-OZ/Gedney-ESR (set screw type) Series.
3) Thomas & Betts-530 (compression type) Series.
4) Emerson-OZ/Gedney-ETR (compression type) Series.

D. Flexible Metal Conduit (FMC)

1. Round flexible conduit, fabricated from a single continuous steel strip. The steel shall be factory formed into continuous interlocking convolutions to form a complete lock between steel strips and provide raceway flexibility.
2. Metal to metal grounding contact shall be maintained throughout the length of the FMC conduit.
3. FMC shall be used only for making motor connections, conduit drop from remote junction boxes to fixtures installed above the suspended ceiling, and as specifically noted on the drawings. FMC shall not be used for runs longer than 8 feet; at any exposed locations; for any conduit size larger than 1-1/4".
4. FMC shall comply with ANSI-C.33.84 and ANSI C33.92; NEMA FB-1; CEC 12-1100.
5. FMC Fittings
   a. FMC fittings shall be malleable iron construction or steel construction.
   b. Fitting shall automatically cause the FMC raceway throat opening to be centered with respect to the fitting throat opening.
   c. Straight and angled connector termination fittings shall be threaded on one end and shall include a threaded locknut, suitable for connection to threaded and unthreaded enclosures.
   d. The attachment of the fittings to FMC shall be angled saddle type, to engage and interlock with the FMC spiral groove, and shall be unaffected by vibration. Direct bearing screw type fittings shall not be used.
   e. Direct FMC conduit-to-FMC conduit coupling of FMC shall not be permitted.
   f. Shall comply with ANSI C33.9, and ANSI C33.92 (latest revision); NEMA FB1 (latest revision); U.L. 514.
6. FMC fittings as manufactured by:
   a. Straight Termination Connectors
      1) Thomas & Betts-3110 Series (with locknut)

      45 & 90 Degree Angle Connectors
      Thomas & Betts-3130 Series (with locknut)
   b. FMC to EMT conduit combination coupling:
      1) Thomas & Betts 503TB Series.

E. Liquid Tight Flexible Metal Conduit (LTFMC)

1. The metal conduit core of LTFMC shall comply with the same requirements as FMC conduit, with the addition of a thermoplastic exterior flexible jacket over the metal core.
2. The exterior jacket shall be positively locked to the metal core to prevent jacket "sleeving".
3. The LTFMC shall be rated for installation and operating service temperatures of between minus 20 degrees centigrade through plus 90 degrees centigrade.
4. The LTFMC jacket shall be suitable for continuous exposure to sunlight, rainwater, water vapor, mineral oils and liquid solvents, without penetrating into the conduit and without deteriorating the jacket.
5. LTFMC sizes from 0.75-inch through 1.25-inches shall include an additional internal ground conductor, fabricated by the manufacturer, as an integral part of the conduit core.
6. Direct LTFMC conduit-to-LTFMC conduit coupling of LTFMC shall not be permitted.
7. LTFMC shall be allowed for conduit size ranges from 0.75-inch through 4.0-inches.
8. In addition to the requirements for FMC conduit, LTFMC shall also comply with ANSI C-33.84 (latest revision); NEMA-FB1 (latest revision); CEC 12-1400 (latest revision).
9. LTFMC fittings
   a. Fittings shall include an external mechanical ground/bond wire connector.
   b. The attachment of the fitting to LTFMC shall be threaded compression type onto the conduit core with locknut and liquid tight jacket compression seal. The fitting shall automatically prevent "sleeving" of the jacket.
   c. Straight and angled termination connector fittings shall be threaded on one end and shall include locknut suitable for connection to threaded and unthreaded enclosures.
10. LTFMC fittings as manufactured by:

a. Termination connector fittings:

Straight	45 and 90 Degree Angle Connectors
1) Thomas & Betts-5331 GR Series.	Thomas & Betts-5341GR and 5351GR Series.
2) Appleton-STB Series; STN-L Series for use with preformed"knockouts".	Appleton-STB-L Series; STN-L Series for use with preformed "knockouts".
3) Emerson- OZ/Gedney-4QSeries.	Emerson-OZ/Gedney-4Q Series

b. LTFMC to RMC conduit to conduit combination coupling fittings:
   1) Thomas & Betts-5271 GR Series.
   2) Emerson-OZ/Gedney-4Q Series

F. Rigid Non Metallic Conduit (RNMC)
   1. General
      a. Conduit and fittings shall be 90 degree centigrade conductor rated. Fabricated from homogeneous material, free from visible cracks, holes or foreign inclusions, with integral "end-bell". The conduit and conduit fittings shall be watertight and airtight.
      b. Conduit, conduit fittings and conduit fitting assembly "solvent cement" shall all be the product of the same manufacturer. Conduit fittings shall be solvent cement welded watertight.
      c. Conduit and fittings shall be identified with legible markings showing ratings, size and manufacturers name.
      d. RNMC and fitting shall be corrosion resistant, watertight.
      e. Conduit shall be suitable for conductor operating temperatures from minus 20 degrees centigrade to 90 degrees centigrade.
      f. RNMC shall comply with NEMA TC-2 (PVC 40 conduit, latest revision) NEMA TC-6 (EB conduit latest revision) and NEMA TC-3 (fittings, latest revision); UL 514 and UL 651 (latest revision).
   2. Polyvinyl Chloride (PVC)-RNMC
      a. PVC-schedule 40 heavy wall construction.
      b. PVC-schedule 80 extra heavy wall construction.
      c. PVC-type EB.
   3. RNMC fittings connecting to metallic raceways shall be provided with a ground/bond jumper connection.

G. Combi-Duct
   1. Rigid nonmetallic conduit combining an continuous linear outer raceway (duct) with factory installed (inside the outer duct) multiple, segregated inner raceway (ducts). Rigid, schedule 40 PVC construction. Shall be modular lengths of 20-feet for each duct segment.
   2. The conduit shall be suitable for use with signal/ telecommunications, fiber optic, telephone and computer/data circuits, operating at 100 volts or less, UL listed and labeled.
   3. Outer Duct, outer enclosing Schedule-40 PVC duct size. The outer enclosing duct shall be 4.2-inches inside nominal duct diameter and 4.5-inches outer duct nominal diameter.
   4. Inner-ducts (Contained inside the enclosing outer duct), non-metallic SDR-19 or Type-C/CAO-8546:
      Triple Combi-Duct
      a. Quantity of three (3) continuous round rigid inner linear ducts, nominal size inside diameter 1.5-inches for each inner duct.
      Quad Combi-Duct
      b. Quantity of four (4) continuous round rigid inner linear ducts, nominal size inside diameter 1.19-inches for each inner duct.
   5. Manufacturer's standard bends and offsets, minimum 72-inches radius.
   6. Combi-duct and combi-duct fittings shall be airtight and watertight. Approved for direct burial in earth and approved for encasement in concrete.

7. As manufactured by Carlon # Multi-Guard/Multi-Cell Series; American Pipe and Plastic (AMTEL) #Multi-Bore series; or equal.

H. Expansion Joint, Deflection Joint and Seismic Joint Conduit Fittings
   1. Expansion Conduit Fitting - Fitting shall provide for a minimum of 2-inches straight line movement between two connecting conduits in each direction (total 4-inches conduit expansion and contraction) parallel to the respective conduit lengths. Fitting shall be watertight.

   2. Deflection Conduit Fitting - Fitting shall provide for a minimum of 30 degrees angular deflection movement ("Shear" deflection) between two connecting conduits, in any direction perpendicular to the length of the respective conduits. Fitting shall be watertight.
   3. Combination Expansion/Deflection Conduit Fitting - Fitting shall provide the combined "expansion" and "deflection" movement capacity between two connecting conduits as described for separate "expansion" and "Deflection" conduit fittings. Fitting shall be approved for installation concealed in both masonry/ concrete construction and exposed non-masonry/concrete construction. Fitting shall be watertight.
   4. Fittings shall comply with UL.
   5. Fittings as manufactured by:
      a. Conduit expansion fittings exposed or concealed locations as manufactured by:
         1) Emerson-OZ/Gedney – AXB-8 Series for RMC conduit.
         2) Emerson-OZ/Gedney - TX Series for EMT conduit.
         3) Appleton – AXB or XJ8 Series for RMC conduit and EMT conduits. Provide RMC to EMT combination conduit coupling fittings for each end of the expansion fitting.
      b. Combination expansion/deflection conduit fittings exposed or concealed conduit locations as manufactured by:
         1) Emerson-OZ/Gedney - AXDX Series for RMC conduit.
         2) Emerson-OZ/Gedney - AXDX Series for EMT conduit.
         3) Appleton-DX Series for RMC conduit.
         4) Provide RMC to EMT combination conduit coupling fittings for each end of the expansion/deflection fitting.
      c. Conduit expansion/deflection fittings for FMC and LTFMC conduit.
         1) Provide a minimum of 12-inches of "slack" LTFMC in each FMC or LTFMC conduit at building and structure seismic or expansion joint conduit crossings.
         2) Note: Each FMC "slack" expansion/deflection location, shall be considered as not less than a 90 degree conduit bend location, for compliance with the maximum quantity of conduit bends allowed in a raceway.
   6. Conduit fitting bonding jumper:
      a. The grounding/bonding path of metal conduit shall be maintained by the fitting.
      b. Provide a bonding jumper at each expansion, deflection and combination expansion deflection conduit fitting.
      c. The jumper shall be a bare flexible copper "braid". The copper braid electrical current carrying capacity shall be equal to the metal conduit.
      d. Provide a factory terminated ground clamp on each end of the braid with adjusting steel conduit grounding clamps and connect to each respective conduit end.
      e. The jumper braid length shall be 8-inches longer than the respective conduit fitting.
      f. Bonding jumper for FMC and EMT fittings as manufactured by:
         1) Emerson-OZ/Gedney – BJ and BJE Series
         2) Appleton – BJ/XJ Series

I. Conduit Bodies Conduit Fitting
   1. Conduit bodies shall provide conductor access with a removable conduit body cover and wiring area enclosed in metal housing. The conduit body shall facilitate pulling conductors.
   2. In-line form "C" conduit bodies shall be prohibited.
   3. The interior space "length" of 90 degree "elbow" conduit bodies shall not be less than six (6) times the diameter size of the largest conduit connecting to the conduit body.

4. Conduit body covers shall be removable, gasketed; watertight “domed” metal covers “Mogul-Type” with threaded screw attachment to the conduit body.
5. Lubricated, reusable, wire roller guards inside the conduit body shall protect wire from insulation damage during wire “pulling”.
6. Conduit body fittings shall comply with UL 514.
7. Conduit bodies as manufactured by:
    a. For RMC Conduit
        1) Hubbell/Killark – LB/Mogul (90-degree elbow) Series – threaded body.
        2) Emerson-OZ/Gedney - LB 6X/Mogul (90 degree elbow) Series - threaded body.
        3) Appleton – NEC6X-LB/Mogul (90 degree elbow) Series - threaded body.
    b. For EMT Conduit
        1) Same as for RMC conduit. Provide EMT to RMC conduit combination coupling fitting for each outlet body connection.

2.02 PVC COATING

A. PVC coatings shall be provided as described for specified metal products.

B. PVC coating shall be factory applied, to comply with NEMA-RN1 and 5-19.

C. The adhesion of the PVC coating to the coated metal shall exceed the strength of the coating itself, based on 0.5-inch “strip-pull” test.

D. Uniform coating thickness shall be continuous without “breaks” or “pinholes” and shall not be less than the following:
    1. Exterior metal surfaces, 40-millimeter coating thickness.
    2. Interior metal surfaces, 10-millimeter PVC or urethane coating thickness (i.e. interior of conduits, interior of conduit fittings etc.).

2.03 CONDUIT SUPPORTS

A. General
    1. Conduit Supports, hangers and fasteners for metal conduit shall be steel, hot dip zinc galvanized.
    2. Conduit supports, hangers and fasteners for PVC coated conduit shall be PVC coated to match the conduit PVC coating.
    3. Threaded hardware shall be continuous, free running threads.
    4. Conduit support systems, including support channels, pipe clamps, braces, anchors, hardware, fasteners, shall be sized to support the full capacity circuit conductors weight, plus the installed conduit weight, plus the conduit fitting weight and support hardware weight, plus a 300% additional weight capacity safety factor.
    5. Provide lock washer at each “bolted”/threaded connection.
    6. Conduit supports, fasteners, channels, braces, hardware, anchors, pipe clamps, and hangers as manufactured by Unistrut or Kindorf.
    7. Supports shall be free of “BURRS” and sharp edges.
    8. Metal supports cut in the field shall be zinc galvanized after cutting to prevent rust.

B. Conduit Hangers
    1. Threaded steel hanger rods.
        a. Hanger rods smaller than 0.375-inches in diameter shall not be used for support of individual conduits.
        b. Hanger rods smaller than 0.5-inches in diameter shall not be used for support of multiple conduits.
    2. Conduit hanger wires shall be not less than 12-gauge steel.
    3. Conduit hangers shall attach to structure fasteners with steel “Clevis” or “Swing” hangers and shall provide a minimum of 45 degrees of angular movement in any direction at the point of the conduit hanger attachment to the structure fasteners.
    4. Conduits individually suspended by conduit hangers shall fasten to the respective hangers with “Clevis” type pipe hangers. The pipe hangers shall be steel, adjustable to fit conduit

size and shall completely enclose the conduit circumference.

C. Conduit Support Channels
   1. "C" channels shall be factory preformed with a minimum 12 gauge thickness metal. The channel shall be factory "punched" with regularly spaced slotted holes for fastener attachments along the length of the channel.
   2. The "C" channel shall not deflect more than 0.1 inches between channel supports at maximum installed design load, including required safety factor.
   3. Channels shall comply with ANSI-1008 (latest revision) and ASTM-A569 latest revision).
   4. Channels shall provide "turned lips" at longitudinal edges to hold (lock-in) fasteners.
   5. Conduit support channels suspended from conduit hangers shall attach to conduit hangers with treaded connections. Provide a minimum of two hangers (trapeze style) connected to each channel.
   6. Non-suspended conduit support channels shall connect to structure fasteners with threaded connectors.

D. Fasteners, Seismic Earthquake Rated
   1. Channel fasteners:
      a. Channel fasteners shall "prelocate" and lock into the channel "turned lips" and channel "walls".
      b. A separate metal strap shall "tie" each conduit to each channel with conduit channel fasteners.
   2. Structure fasteners:
      a. Structure fasteners for wall and floor mounted conduit attachments shall attach to existing masonry and concrete structures with structure fasteners using drilled, mechanical, expansion shield anchors.
      b. Structure fasteners for wall and floor mounted conduit attachments shall attach to new masonry and concrete structures with structure fasteners using steel threaded inserts precast into the structures.
      c. Structure fasteners shall center the support load above or below the beam flanges and reduce torsion-rotation forces exerted on the structural beam. Attach to steel structural members with "swing-beam clamps", with set-locking screw structure fasteners.
         1) Beam clamps shall include integral safety rod, strap or "J"-hook to secure the attachment clamp to the beam flanges on both sides of the beam, with integral hanger rod attachment.
         2) Or double-ended beam clamp to secure the attachment clamp to the beam flanges on both sides of the beam, with integral hanger rod attachment.
      d. Structure fasteners for wall and floor mounted conduit attachments shall attach to wood structural members with flush "through-bolted" wood beam/wood framing stud structure fasteners.
      e. Structure fasteners for wall mounted conduit attachments shall attach to steel framing studs and steel structural elements with spot welded steel structure fasteners or drilled and bolted structure fasteners.

E. Brace Connectors
   1. Provide lateral brace connectors to resist horizontal, lateral and vertical movement of suspended conduits during seismic earthquakes.
   2. The braces shall connect from each conduit support, attach as close to the conduit as possible, and attach to fixed rigid, nonsuspended building "main" structural elements with fixed anchoring.
   3. Brace attachment connectors and fasteners shall be rigid preformed steel channels or flexible #10 gauge steel hanger wire.
   4. Connect and attach the brace connectors to fixed structural elements in the same manner as conduit support hangers. The connection of braces to structural elements shall be independent of the conduit support hanger structure fasteners.

2.04 ELECTRICAL POWER WIRE AND CABLE

A. General
1. All wire and cable shall be single-conductor, annealed copper, insulated 600 volt, #12AWG minimum unless specifically noted otherwise on the drawings.
2. Conductors #10AWG and smaller shall be solid. Conductors #8AWG and larger shall be stranded.
3. Insulation of conductor connected to circuit protection devices required to be "100%" rated, shall be 90 degree centigrade rated insulation.
4. Insulation of conductors installed outdoors, on grade or underground, insulation shall be rated for wet locations.
5. Insulation of conductors installed outdoors, installed exposed to the sun, installed in exposed conduits, insulation shall be rated for high-temperature 90 degrees centigrade.
6. Insulation of branch circuit conducts installed in light fixtures, insulation shall be rated for 90 degrees centigrade.
7. Conductor exposed to oil, insulation and jacket shall be oil resistant, complying with “Oil Resistant-1” and “Oil Resistant-2” UL 83.

B. Conductor Insulation
1. 600 Volt AC and/or DC insulated conductors installed entirely inside conduits, or enclosed inside wireways, or enclosed inside raceways, insulation shall be rated as follows.
2. Indoor above Grade locations either concealed or exposed.
   a. Dual rated THHN and THWN
   b. Individually rated THHN-2
   c. Individually rated THWN-2
   d. XHHW-2
3. Outdoor above Grade either concealed or exposed.
   a. XHHW-2
   b. THWN-2
   c. THW-2
4. Outdoor below Grade or outdoor on Grade.
   a. XHHW-2
   b. THWN-2
   c. THW-2
5. All other enclosed raceway locations not described above.
   a. XHHW-2
   b. THWN-2
   c. THW-2
6. Health Care facilities all circuits insulation shall be XHHW-2, rated Hospital-Grade.
7. 600 Volt AC and/or DC insulated conductors installed in open cable tray or open wireway or exposed insulation also shall be rated for exposed install locations.

C. Insulation Color Coding and Identification
1. The following color code for branch circuits:
   a. Neutral . . . White (Tape feeder neutrals with white tape near connections)
   b. Normal Power:

120/208 Volt		480/277 Volt	Ground
Green		Ground	Green
Phase A	Black	Phase A	Brown
Phase B	Red	Phase B	Orange
Phase C	Blue	Phase C	Yellow

   c. Isolated ground insulation shall be green with a longitudinal yellow stripe.
   d. Emergency power same insulation color as normal power except as follows:

120/208 Volt	480/277 Volt
Provide a continuous stripe on each conductor insulation, orange or	Provide a continuous stripe on each conductor insulation blue or black, except ground

yellow, except ground

2. When individual neutral conductors are shown for each branch circuit, the color code for the neutral conductors shall be as follows:
   a. 120/208 volt; Phase A - White with Black stripe; Phase B - White with Red stripe; Phase C - White with Blue stripe.
   b. 277/480 volt; Phase A - White with Brown stripe; Phase B - White with Orange stripe; Phase C - White with Yellow stripe.
3. Feeders identified as to phase or leg in each, switchboard, switchgear, panelboard and junction location with printed identifying tape.
4. Fire alarm conductors: Use 600-volt, type THHN-2/THWN-2 conductors and color-coded per equipment manufacturer's recommendations and approved and listed for use on fire alarm systems by the State Fire Marshal.
5. Color coding for mechanical and plumbing control wiring shall be an agreed upon color code between the Mechanical/Plumbing CONTRACTOR and the Electrical CONTRACTOR, and color code shall be submitted to the DISTRICT'S REPRESENTATIVE in writing for approval prior to installation.

D. Panel feeders shall be copper:
1. Wire size shown on the drawings is for copper conductors, unless specifically indicated otherwise.
2. If the conductor termination is to be made on a bus bar or similar flat surface, a Burndy Type YA-A HYPLUG compression terminal intended for the specific conductor size, factory filled with oxide inhibitor compound shall be used. Terminal must be installed using a hydraulic compression tool equipment with a die head for the particular terminal used. Only Burndy Hypress tools shall be used for compression.
3. If the conductor termination is to be made into a circuit breaker or similar insert compartment it shall be terminated by use of a Burndy AYP HYPLUG compression connector intended for the specific conductor size, factory filled with oxide inhibitor compound. Connector must be installed using only Burndy Hydraulic compression tool specifically approved for each respective connector.
4. Connector aid shall be used for all terminations and connections. Connector aid shall be Burndy Pentrox A, NO-OX-1D Grade "A".
5. When an aluminum lug is terminated to a copper bus with a steel or copper stud or bolt, place aluminum lug on stud or bolt followed by a flat steel washer, a Belleville washer, and steel or copper nut, in that order.

2.05 CHEMICAL GROUND ROD

A. General
1. Self contained ground rod(s) using chemically enhanced grounding shall be provided where specifically indicated on the drawings. As manufactured by Lyncole XIT Grounding Systems, 22412 South Normandie Avenue, Torrance, CA. Telephone #(800) 962-2610; or Superior Grounding Systems, Irwindale, CA. Telephone #(800) 747-7925; or ERICO – Eritech Chemical Ground Electrode.

2. The ground rod shall operate from changes in atmospheric pressure pumping air through the ground rod, hygroscopically extracting moisture from the air to activate the ground electrolytic chemicals and improve the ground rod performance.
3. Ground rod system shall be UL-467 listed.
4. Ground rod system shall be 100% self-activating, sealed and maintenance free. The addition of chemical or water solutions shall not be required.

B. Ground Rod
1. Ground rod shall consist of a 2-inches nominal diameter hollow, copper tube. The tube shall be permanently capped on the top and bottom. Air breather holes shall be provided in the top of tube. Drainage holes shall be provided in the bottom and sides of the tube for

electrolyte drainage into the surrounding soil.

2. The ground rod shall be chemically filled at the factory with environmentally non-hazardous water-soluble metallic salts to enhance electrical grounding performance.
3. Ground rod shall be a minimum of 10-feet long for straight (vertical) installation; or “L” shape minimum 20-feet long for horizontal installation.
4. Ground wire clamping “U-Bolt” with pressure plate on the top end of the tube sized for 1#2 through 500 MCM AWG ground electrode conductor connection, and stranded 4/0AWG copper pigtail exothermically welded to the side of rod for ground electrode conductor connection.

C. Ground Box
1. Precast concrete box with slots for conduit entrances. Approximately 10-inch diameter by 12-inches high. Cast iron grate flush cover with “Breather” slots XIT Box #XB-12.

D. Backfill Material
1. Natural volcanic, non-corrosive Bentonite Clay backfill material.
2. Shall absorb water at a minimum of thirteen times its dry volume or approximately 14 gallons for 50 pounds of clay.
3. PH value 8-10 with maximum resistivity of 2.5 OHMS-M at 300% moisture content by weight.

2.06 FLEXIBLE CORDS AND PORTABLE CABLES

A. General
1. Multi-conductor insulated flexible cable with jacket rated extra heavy duty, extra hard-use and high abuse duty; ozone, sunlight, grease, oil resistant-UL 83 and water resistant; rated for indoor/outdoor use.
2. Quantity of conductors and conductor sizes as indicated on the drawings but in no case less than five 16AWG.
3. Characteristics:
   a. Conductors - stranded copper, soft annealed conforming to ASTM-B-174 and ASTM-B-172. 600 volt individually insulated and color-coded. Separate green insulated ground conductor. Aluminum conductors shall not be permitted for cords and cables.
   b. Insulation - rubber conforming to UL 62; temperature range plus 105 Centigrade to minus 50 Centigrade.
   c. Flame resistance shall conform with MSHA-P123-103.
   d. Jacket - black for equipment connections and yellow for outlet connections. Rated for temperature range plus 105 Centigrade to minus 50 Centigrade, water, sunlight and ozone resistant. Permanently mark jacket a minimum of 40-inches on center with rated voltage, manufacturer's name, wire/insulation type, AWG conductor size and quantity (minimum 24-inches on center).

2.07 CABLE RACKS

A. Cable racks, installed on the vertical walls of the structure, including hooks and porcelain insulator cable cradles, shall be sufficient to accommodate the cables and splices.

B. Vertical racks shall be installed on all walls of the structure a minimum of 24-inches on center within 6-inches of floor and top of wall. A rack shall be installed within 18-inches of each corner of each wall. Additional racks spaced equally on each wall shall be installed; spacing between vertical wall racks shall not exceed 24-inches.
1. Wall racks shall be slotted to accept removable hooks and lock hooks into place.
2. Non-metallic, 50% (minimum) glass reinforced nylon or non-metallic material of the same characteristics.

3. The installed cable racks, cable support hooks with arms and wall anchor bolts shall support the following minimum loads for each hook/arm, with a 200% minimum safety factor. Based on multiple hook/arms located not less than 9-inches on center along the entire vertical length of the support rack:

Hook/Arm Length	Min. Weight Each Hook/ Arm Supported	Max. Allowable Hook/ Arm Deflection
a. 8-inch	450 pounds	0.25-inch
b. 14-inch	350 pounds	0.37-inch
c. 20-inch	250 pounds	0.37-inch

(Based on load concentrated 1-inch from the end of each hook/arm.)

4. Racks shall be bolted to the precast and cast-in place structure walls, within 3-inches of each rack end and not less than 9-inches on center. Provide cast-in place or after-set drilled expansion concrete anchors.

PART 3 - EXECUTION

3.01 TRENCHING, FOOTINGS, SLEEVES

A. Provide trenching, concrete encasement of conduits, backfilling, and compaction for the underground electrical work, in accordance with applicable sections of this specification.

B. Provide footings for all post and/or pole-mounted lighting fixtures: concrete shall conform to the applicable sections of this specification.

C. Sleeves
   1. Provide sleeves for raceways, conduit and wire/cables passing through the following construction elements:
      a. Concrete and masonry foundations, floors, walls and slabs.
      b. Gypsum, Lath, and plaster walls and ceilings.
      c. Building structures (i.e., foundations, walls, floors, ceilings, beams, and roofs) with a fire rating exceeding 20-minutes.
   2. Sleeves shall extend 1.5-inches above and below floors, except under floor standing electrical equipment. Sleeves shall be flush with wall ceiling foundations and partitions exposed to public view and extend approximately 0.5-inches past penetration in fire rated construction. Sleeves shall be installed at exact penetration locations and angles to accommodate wire/cable, raceway and conduit routings.
   3. Joists, girders, beams, columns or reinforcing steel shall not be cut or weakened. Where construction necessitates the routing of conduit or raceways through structural members, framing or footings, written permission to make such installation shall first be obtained from the DISTRICT'S REPRESENTATIVE. Such permission will not be granted, however, if any other method of installation is possible.
   4. The layout and design of raceways and conduits located in or routed through masonry or reinforced beams or the DISTRICT'S REPRESENTATIVE shall review walls before any work is performed. All sleeving shall be accomplished according to the instructions of the DISTRICT'S REPRESENTATIVE and shall be accepted before any concrete is poured.
   5. Sleeves, raceways and conduit shall be located to clear steel reinforcing bars in beams. Reinforcing bars in walls shall be offset to clear piping and sleeves.
   6. Provide a continuous clearance between the inside of a sleeve and exterior of wire/cables, conduits and raceways passing through the sleeve not less than the following:
      a. 0.5-inch clearance except as required otherwise.
      b. 1.0-inch clearance through outside walls below grade.
      c. 3.0-inch clearance through seismic joints.
   7. Sleeves set in fire rated construction shall be caulked between sleeve and building structure, additionally sleeves shall be caulked between the sleeve and the wire/cables, conduits/raceways passing through the sleeve. The caulking shall be a fireproof sealant, equal to the fire rating and temperature being penetrated. Clearance between components inside of sleeve and exterior of components passing through sleeve and between components inside the sleeve shall comply with fireproof sealant manufacturer's

recommendations.

8. Sleeve material:
   a. In floor construction: Schedule 40 black steel pipe, with upper surface to be sealed watertight.
   b. In concrete or masonry walls roofs or ceilings: Schedule 40 black steel pipe. When installed in roofs or outside walls, seal outer surface watertight.
   c. In fire rated construction; 24 gauge galvanized iron or steel.
   d. Sleeves through waterproof membranes: Cast iron or Schedule 40 steel with flashing clamp device and corrosion resistant clamping bolts. Caulk space between pipe and sleeve and surfaces between sleeve and conduits sealed watertight.

3.02 GROUNDING

A. Grounding shall be executed in accordance with all applicable codes and regulations, both of the State and local authorities having jurisdiction.

B. Where nonmetallic conduit is used in the distribution system, the CONTRACTOR shall install the proper sized copper ground wire in the conduit with the feeder for use as an equipment ground. The electrical metallic raceway system shall be grounded to this ground wire.

C. The maximum ground/bond resistance to the grounding electrode shall not exceed 1 ohms from any location in the electrical system. The maximum ground resistance of the grounding electrode to earth shall not exceed 5 ohms.

D. Ground/Bond Conductors
   1. Provide an additional, dedicated, green insulation equipment ground/bond wire inside each conduit type and raceway as follows. Size the ground/bond conductors to comply with CEC/NEC requirements. The metal conduit or raceway shall not be permitted to serve (function) as the only (exclusive) electrical ground return path:
      a. All types of nonmetallic conduit and all types of non-metallic raceways including but not limited to: RNMC - Rigid Nonmetallic Conduit.
      b. FMC - Flexible Metal Conduit.
      c. LTFMC - Liquid Tight Flexible Metal Conduit.
      d. Metal and non-metal raceways.
      e. RMC - Rigid Metal Conduit.
      f. EMT - Electrical Metal Tubing.
   2. The equipment ground/bond wire shall be continuous from the electrical circuit source point of origin to the electrical circuit end termination utilization point as follows:
      a. Every conduit and raceway path containing any length of the above identified conduits or raceway.
      b. Every conduit path and raceway path connected to any length of the above-identified conduits and raceways.

   3. The equipment ground/bond wire shall be sized as follows, but in no case smaller than indicated on the drawings. Install equipment ground/bond wire in each conduit/raceway, with the respective phase conductors:
      a.

Feeder, Subfeeders & Branch Circuit Protection	Min. Equipment Ground Wire Size
15 Amp	#12
20 Amp	#12
30 to 60Amp	#10
70 to 100 Amp	#8
101 to 200 Amp	#6
201 to 400 Amp	#2
401 to 600 Amp	#1
801 to 1000 Amp	2/0
1001 to 1200 Amp	3/0

1201 to 1600 Amp	4/0
1601 to 2000 Amp	250 MCM
2001 to 2500 Amp	350 MCM
2501 to 4000 Amp	500 MCM

4. Isolated grounds - Raceways containing branch circuit or feeder phase conductors connected to panelboards equipment, or receptacles with isolated grounds or isolated ground bus shall contain a dedicated insulated ground conductor connected to the isolated ground system only. The isolated ground conductor shall be continuous the length of the raceways and connected only to the isolated ground terminals in addition to and independent of the equipment bonding/ground conductor. The isolated ground conductor shall be sized as indicated above, for equipment ground/bond wire.
5. Splices in ground/bond wires shall be permitted only at the following locations:
   a. Ground buses with listed and approved ground lugs.
   b. Where exothermic welded ground/bond wire splices are provided.
6. Provide ground/bond wire jumpers for conduit fittings with ground lugs, expansion and deflection conduit fittings at conduit fittings connecting between metallic and non-metallic raceways and to bond metal enclosures to conduit fittings with ground lugs.

E. Where conductors are run in parallel in multiple raceways, the grounding conductor shall be run in parallel. Each parallel equipment-grounding conductor shall be sized on the basis of the ampere rating of the overcurrent device protecting the circuit conductors in the raceway. When conductors are adjusted in size to compensate for voltage drop, grounding conductors, where required, shall be adjusted proportionately in size.

F. Ground conductors for branch circuit wiring shall be attached at each outlet to the back of the box using drilled and tapped holes and washer head screws, 6-32 or larger.

G. Each panelboard, switchboard, pull box or any other enclosure in which several ground wires are terminated shall be equipped with a ground bus secured to the interior of the enclosure. The bus shall have a separate lug for each ground conductor. No more than one conductor shall be installed per lug.

H. UFER Ground
1. In addition to all cold water and structural steel grounds provided to meet this specification, there shall be a main ground system of the UFER ground style.
2. The UFER ground electrodes shall be a minimum of two (2) 20-feet lengths of #4/0 AWG bare stranded copper cable embedded horizontally in the cast in place concrete footing, extending in opposite directions in the footings. All portions of the ground electrodes shall be placed inside the concrete, between 2-inches and 4-inches from the earth surrounding the concrete.
3. The lengths of cable shall extend in opposite directions in the footings, with the center end of each cable terminated onto the main electrical service ground bus for the main electrical service equipment.
4. All wire cable connection terminations onto the ground bus shall be exothermic weld type.
5. The “UFER” grounding electrode, embedded in concrete, shall be exothermically welded to each steel reinforcing bar (rebar) and each steel anchor bolt located within 18-inches of the grounding electrode inside the concrete. Note: Reinforcing steel (rebar), in concrete foundations, attached with metal “tie-wraps” and in direct physical contact to other adjacent rebar that is in turn exothermic welded to the UFER grounding electrode, may be classified as attached to the UFER grounding electrode, and does not require additional exothermic weld connections to the UFER grounding electrode.

I. Provide a separate ground/bond insulated grounding electrode conductor, copper wire from the main electrical service ground bus to each of the following locations. The ground/bond conductor shall be sized to comply with applicable codes and as indicated on the drawings, but in no case

smaller than the following:

1. Main service entrance equipment ground bus:
   a. Services smaller than 1200 ampere 1.5-inch conduit with 1#4/0.
   b. Services 1200 ampere and larger 2.5-inch conduit with 1#500MCM.
   c. Where a separate ground bus is not required, connect ground to electrical equipment metal housing
2. Each telephone backboard and signal system backboard location, 1.25-inch conduit with 1#1.
3. Metal cold water pipe located inside the building, 1.5-inch conduit with 1#4/0.
4. Outdoor underground metal cold water pipe, make connection five feet from the building, 1.5-inch conduit with 1#4/0.
5. Each transformer (size as indicated and to comply with applicable codes).
6. Each service entrance ground bus and each separately derived ground rod system:
   a. Services smaller than 1200 ampere 1.5-inch conduit with 1#4/0.
   b. Services 1200 ampere and larger 2.5-inch conduit with 1#500MCM.
7. Separate 1.25 inch conduit with 1#2 (AWG) bonding conductor to each interior metal pipe system located in the same building, including but not limited to, the following:
   a. Fire sprinkler system each stand pipe location (water based and non-waterbased).
   b. HVAC chilled water supply and return, at each pump location.
   c. Roof drains.
   d. Waste liquid disposal systems.
   e. Metal gas pipe service entrance and service meters.
   f. Hydraulic elevator hydraulic pipes.

3.03 CONDUIT

A. General

1. The sizes of the conduits for the various circuits shall be as indicated on the drawings, but not less than the conduit size required by code for the size and quantity of conductors to be installed in the conduit.
2. Conduits shall be installed concealed from view. Install conduits concealed in walls, concealed below floors and concealed above ceilings, except as specifically noted otherwise.
   a. Conduits shall not be installed in concrete floors.
3. The following systems shall be considered as circuits 100 volts and less, all other circuits shall be considered to be over 100-volts (power circuits) unless specifically noted otherwise: Fire alarm, energy management control, telephone, public address, data, computer, television, intercom, intrusion alarm and nurse call.
4. Conduits shall be provided complete with conduit bends, conduit fittings, outlet boxes, pullboxes, junction boxes, conduit anchors/supports, grounding/bonding for a complete and operating conductor/wire raceway system.
5. Metal and nonmetal conduits shall be provided mechanically continuous between termination connection points. Metal conduit shall be provided electrically continuous between termination connection points.
6. Individual conduit paths and home runs shown on the drawings shall be maintained as separate individual conduits for each homerun and path.
7. Conduits, conduit fittings and installation work occurring in classified hazardous materials locations shall comply with applicable code Class 1 Division 1 requirements, unless specifically noted otherwise.
8. Transitions between conduits constructed of different materials and occurring in above grade locations shall be allowed only at outlet boxes, junction boxes, pull boxes, and equipment enclosures unless specifically indicated otherwise. Provide outlet boxes and junction boxes.
9. Metal conduit terminating to nonmetal enclosures; terminating into metal enclosures with “concentric.ring” knockouts; terminating into metal enclosures with knockout reducing

washers, including but not limited to equipment housings, outlet boxes, junction boxes, pull boxes, cable trenches, manholes, shall be provided with a ground/bonding lug integrated with the conduit termination conductor fitting construction, by the fitting manufacturer. The lug shall provide for connection of a grounding/bonding conductor (insulated or uninsulated). The grounding lug shall be located on the fitting, inside the termination enclosure.

10. The type of conduit, type of conduit fittings, and type of conduit supports and method of conduit installation shall be suitable for the conditions of use and conditions of location of installation based on the manufacturer's recommendations; based on the applicable codes and based on the requirements of the contract documents.

B. RMC Installation Locations

RGS, IMC conduits and RGS, IMC fittings shall be installed in the following locations:

1. Embedded in floors, walls, ceilings, roofs, foundations, and footings constructed with concrete.
2. Embedded in walls and foundations constructed with brick and masonry.
3. Interior of buildings, within 9-feet of finish floor lines for exposed conduit locations.
4. Exterior of building for exposed conduit locations.
5. Damp or wet locations, exposed or concealed locations.
6. Exposed on roofs.
7. In hazardous materials areas and locations; below hazardous materials areas and locations; above hazardous materials areas and locations.
8. Exposed on utility service poles, for pole risers less than 9-feet above finish grade.
9. RMC conduit and RMC fittings may be installed in any location where EMT and FMC conduit is permitted to be installed.

C. PVC Coated RMC Installation Locations

PVC coated RMC conduit and PVC coated RMC fittings shall be installed in the following locations:

1. Underground conduit locations for elbows and bends with a radius of less than 36-times the conduit diameter.
2. Underground vertical risers extending above grade.
3. Entire length of underground conduits for the following circuits:
   a. Audio microphones
   b. Lighting dimming controls
4. Installed in contact with earth or corrosive materials.
5. Exposed in "cold" rooms and "refrigerated" rooms, rooms with a maintained temperature below 65 degrees Fahrenheit.

D. EMT Installation Locations

EMT conduit and EMT fittings may be installed in the following locations, for circuit conductors operating below 600 volts to ground; locations containing only "non-hazardous materials"; only dry locations:

1. Concealed in hollow non masonry/non-concrete, metal stud frame and wood stud frame walls and floors.
2. Concealed above ceilings.
3. Exposed inside interior enclosed crawl spaces.
4. Exposed interior locations placed 10-feet or higher above finished floors (except as described in paragraph below at lower heights).
5. Exposed on walls and ceilings (any height) in the following dedicated function areas, interior enclosed room locations:
   a. Indoor enclosed electrical equipment rooms and closets.
   b. Indoor enclosed data and telecommunication terminal rooms and closets.
   c. Indoor enclosed HVAC equipment rooms and closets.
6. Any location where FMC is described to be installed, except as the final connection to

rotating or vibrating equipment.

E. FMC Installation Locations

FMC conduit and FMC fittings may be installed in the following locations for circuit conductors operating below 600 volts to ground; locations containing only “non-hazardous materials”; only dry, interior locations:

1. Concealed in hollow non-masonry metal stud frame and wood stud frame fully enclosed walls.
2. Concealed above fully enclosed ceiling spaces.
3. FMC conduit shall be installed in continuous lengths between termination points. FMC shall not be “spliced” or coupled directly to FMC or any other conduit type under any circumstance.
4. The maximum continuous length of FMC that shall be installed between termination end points is 8-feet. Circuits requiring continuous conduit lengths exceeding 8-feet between termination end points shall be installed using either RMC or EMT conduits. FMC lengths shorter than 16-inches are prohibited.
5. The minimum size FMC conduit shall be as shown on the drawings but not be less than the following:
   a. FMC lengths of six feet or less, minimum FMC conduit size shall be 0.75-inch.

F. LTFMC Installation Locations

LTFMC conduit and LTFMC fittings shall be installed in the following locations for circuit conductors operating below 600 volts to ground; locations containing only “non-hazardous materials”:

1. Final electrical connection to vibrating or rotating equipment; control and monitoring devices mounted on vibrating and rotating equipment including the following. Minimum conduit length shall not be less than 24-inches:
   a. Motor, engines, boilers, solenoids, and valves.
   b. Fixed mounted “shop” (manufacturing) production equipment.
   c. Fixed mounted food preparation equipment and “kitchen” equipment.
2. All locations where exposed flexible conduit connections are required, both indoor and outdoor.
3. Final connection to indoors electrical transformers. Minimum conduit length shall not be less than 24-inches; maximum conduit length shall not exceed 72-inches.
4. Do not install LTFMC located in environmental air plenums.

G. RNMC Installation Locations

RNMC conduit and RNMC fittings shall be installed in the following locations containing only “non-hazardous material”:

1. Underground, concealed below earth grade, unless specifically noted or specified otherwise.
2. Exposed on utility service poles, for pole risers at 9-feet or higher above finish grade, schedule 80 PVC only.
3. RNMC type “EB” conduit(s) shall be concrete encased along the entire length of the conduits for all installation locations.

4. Non-metal type raceways and RNMC type conduit shall not be installed inside buildings.

H. Combi-Duct Installation Locations

Combi-duct conduits shall be installed where shown on the drawings. Combi-duct shall be installed underground (below grade) as follows:

1. Do not install exposed or inside buildings above grade.
2. Provide a 0.25-inch pull rope in each inner duct.
3. Radius and elbows shall be rigid non-metallic, PVC, manufacturer factory fabricated, in lieu of PVC coated RMC conduit.
4. Inner ducts shall be supported by internal spacers inside the enclosing outer duct.
5. Provide end bell and three (3) hole "snug-plugs" at each entrance end of Combi-duct into

pullboxes, manholes, equipment cabinets stubups and Combi-duct terminations. Compression type “snug-plugs” shall provide watertight and airtight seal between inner and outer ducts and around future cables installed in inner duct.

I. Conduit Installation
1. Conduit Supports
a. Securely and rigidly support all raceways/conduits from the building structure. Raceways/Conduits shall be supported independent of all piping, air ducts, equipment ceiling hanger wires, and suspended ceiling grid systems. Secure conduit to structural element by means of UL listed and approved hangers, fasteners, “C” channels and pipe clamps.
b. Provide conduit supports spaced along the length of the conduit as follows:
1) RMC and EMT conduit, maximum not to exceed 96-inches on center; within 24-inches of each conduit bend and conduit termination location.
2) FMC and LTFMC conduit, maximum not to exceed 24-inches on center; within 6-inches of each conduit bend and conduit termination location.
c. Suspended conduit methods:
1) Individual, suspended raceways/conduits separated by more than 12-inches from any other conduit and suspended from ceilings and roofs shall be supported as follows:
a) Conduits smaller than 1.5-inches by means of hanger rods or hanger wires.
b) Conduits 1.5-inches and larger by means of hanger rods.
c) The conduit shall attach to the hangers with pipe clamps.
2) Suspended raceways/conduits positioned within 24 inches of any other conduit shall be grouped and supported by hanger rods using trapeze type conduit support channels ("C" channels). Conduits shall individually attach to common channels side-by-side, with pipe clamps.
d. Non-suspended conduit methods:
1) Individual raceway/conduits placed against wall/ceiling/floors, placed inside hollow wall/ceiling construction or structure framing (i.e., “dry- wall” or plaster hollow wall construction), shall be secured by means of individual pipe clamps and fasteners attached to the framing studs or other structural members and the conduit/raceway.
2) Provide common “C" channel supports for all multiple raceway/conduits placed against vertical or horizontal surfaces and positioned within 24-inches of other raceways/conduits. Attach channels to the framing studs or other structural members. Attach the conduits/raceway individually to common channels, side-by-side, with pipe clamps.
3) The use of toggle bolts is prohibited.
e. Conduit rising from floor for motor connection shall be independently supported if extending over 18-inch above floor. Support shall not be to a motor or ductwork, which may transmit vibrations.
f. Provide conduit anchoring, conduit support and conduit bracing systems conforming to Earthquake Seismic Zone 4 requirements. The conduit support/ anchoring system capacity shall include the weight of the conduits, conduit fittings, conduit supports and conductors/wires/cables installed in the conduits plus a 300% safety factor. Submit shop-drawing details showing each typical conduit anchor, conduit support and conduit brace location. Submit structural calculations performed by and signed by a Professional Structural Engineer (P.E.) with a P.E. license, registered in the state of California, U.S.A.
2. Conduit separation:
a. Conduit installed underground or below building slab without full concrete encasement: Shall be separated from adjacent conduits of identical systems (i.e. signal to signal, data to data, power to power, control to control etc.) by a minimum of 3-inches. Conduits of non-identical systems (i.e. signal to power; data to power; power to control; signal to control, etc.) shall be separated by a minimum of 12-inches.
b. Conduit installed underground with full concrete encasement; shall be separated from

adjacent conduits of similar systems (100 volt and less) by a minimum of 2-inches; conduits for non power systems (100 volts and less to ground) shall be separated by a minimum of 6-inches from power circuits (over 100 volts to ground); conduits for power circuits shall be separated from adjacent conduits of similar power systems (over 100 volts to ground) by a minimum of 3-inches.

c. Separation of conduits entering termination points or crossing other conduits may be reduced as required within 60-inches of the termination or crossing points.

d. Conduits containing Utility Company service circuits (i.e. electrical power, telephone, or cable television) shall be separated a minimum of 12-inches from all other utilities and conduits, with or without concrete encasement; metallic or non-metallic conduit, above grade or underground conduit locations.

e. Conduits shall be separated from hot water piping, exhaust flues/chimneys, steam piping, boilers, furnaces, ovens by a minimum of 12-inches.

3. Conduit stubs:

a. Branch circuit and telephone conduits turned up from floor at the following locations shall terminate each conduit in a flush conduit coupling at the floor and then extend into partition or to equipment. Refer to DISTRICT'S REPRESENTATIVE'S drawings for location of walls and partitions.

1) Interior demountable partitions.
2) Below, into or adjacent to equipment not installed directly adjoining to a wall.
3) Up from below the floor into hollow stud frame walls.

b. From each panel, and signal cabinet which is wall mounted, stub up from top of the panel/cabinet a minimum of (3) three 1-inch conduits to the nearest accessible ceiling spaces or other accessible location. Where the floor below the panel is accessible or is a ceiling space, stub an additional (3) three 1-inch conduits from the bottom of the panel into the accessible space below the panel. Cap conduits for future use.

c. Conduits stubbed underground outside of building line for future use shall be terminated a minimum of five feet clear (whichever distance is greater) of building or adjacent concrete walks and AC paving. The stubout conduit shall be capped. Provide concrete monuments, 6-inches by 6-inches by 15-inches deep, buried flush with grade over the capped ends. The face of monument shall be furnished with 3-inch square brass plates securely mounted and engraved with the number and size of conduits and type of service (i.e., "POWER", "TEL.", etc.).

d. Conduits stubbed into ceiling or floor spaces from outlets for telephone, video, computer/data or television shall be provided with an insulated throat bushing, on the end of each conduit stubout.

e. Conduit stubouts from outlet boxes and equipment located in hollow stud walls, into ceiling and floor spaces, shall be EMT or RMC conduit. The stubouts shall terminate into the ceiling and floor spaces with a conduit termination connector fitting.

f. Empty conduit stubs into building spaces and equipment shall be individually identified with a "ID-tag" located at each end of the conduit. The ID-tag shall state the origination point and termination point of the respective conduit (i.e., "from PNL-A/to Room #121"; "from outlet #24/to outlet #17 in Room #120"; etc.).

g. Provide a conduit termination fitting with insulated throat bushing and mechanical ground lugs at each conduit "stub-up" location.

4. Conduit concrete encasement:

a. Conduits which are run underground exterior to building slab shall be continuously concrete encased except, 15 and 20-ampere power branch circuit conduits underground do not require concrete encasement.

b. PVC rigid-non-metallic-type EB conduit, of any size and any location shall be continuously concrete encased the full length of the conduit installation, including under building slab.

c. Concrete for encasement of underground conduits shall be 2000-PSI 28-days cure strength with a mix of cement, sand, water and maximum of ¾-inch gravel. Concrete encasement of conduits shall be continuous without voids. The encasement shall extend

3-inches past the edges of all conduits on all sides of the circuit. Provide ten pounds of red oxide cement coloring uniformly mixed with each cubic yard of concrete for conduit encasement.

d. Conduits located below or adjacent to structural foundations shall be separated from the foundation by a minimum of 12-inches. Conduits located below structural foundations shall be fully and continuously concrete backfilled and encased between the bottom of the foundation to the bottom of the conduits. The concrete shall be 4000 PSI 28 day cure strength instead of 2000-PSI concrete.

e. Conduits of any size and type (including 15 ampere and 20 ampere power branch circuits) located under roads, paved areas and "transit-system" right of way shall be concrete encased.

5. Underground conduits:

a. Three or more underground conduits larger than 1-inch in size and occupying the same trench shall be separated and supported on factory fabricated, non-metallic, duct/ conduit support spacers. The spacers shall be modular, keyed interlocking type, "built- up" to accommodate quantity, size orientation and spacing of installed conduits.
The spacers shall maintain a constant distance between adjacent conduit supports and hold conduits in place during trench backfill operations. Minimum support spacer installation interval along with length of the conduits shall be as follows:
1) Concrete encased conduits, not less than 8-feet on center.
2) Non-concrete encased conduits, not less than 5-feet on center.

b. Provide trenching, excavation, shoring and Backfilling required for the proper installation of underground conduits. Tops of backfill shall match finish grade.

c. Bottoms of trenches shall be cut parallel to "finish grade" elevation. Make trenches 12-inches wider than the greatest diameter of the conduit.

d. Back-filling Trenches for Conduits without Concrete Encasement Requirements
1) Conduits which are not required by the Contract Documents to be concrete encased and are located exterior to building slab, shall be set on a 3-inch bed of damp clean sand. Conduit trenches shall be backfilled to within 12-inches of finished grade with damp sand after installation of conduit is completed. Remainder of backfill shall be native soil.
2) Conduits located under a building which are not required by the Contract Documents to be concrete encased, shall be completely backfilled and compacted with clean damp sand to the same level as the building foundation pad.
3) Provide a continuous yellow 12-inches wide flat plastic tracer tape, located 12-inches above the conduits in the trench. The tracer tape shall be imprinted with "Warning-Electric Circuits" a minimum of 24-inches on center.

e. Backfilling trenches for conduits under paved areas:
1) In addition to the requirements of conduit concrete encasement, conduits under walkways, roads, parking lots, driveways, and buildings shall be cast in place concrete "slurry mix" backfill. The slurry mix shall cover each side and top of conduits and conduit concrete encasement. The slurry mix shall be continuous to the underside of the finish subgrade surface.

f. Backfilling trenches for conduits with concrete encasement requirements by the contract documents:
1) Trenches with all conduits concrete encased, shall be backfilled with clean damp sand when located under building pads.
2) Trenches with all conduits concrete encased and not located under a building pad and not located under paved areas, shall be backfilled with clean damp sand or native soil.

g. Backfill material:
1) Sand and native soil backfill of trenches shall be machine vibrated in 6-inch lifts to provide not less than 90% compaction of backfill.
2) Soil backfill shall have no stones, organic matter of aggregate greater than 3-inches.

3) Concrete and slurry mix (2000-PSI) shall be machine vibrated during installation to remove “air-voids”.
4) The slurry mix shall consist of concrete, clean rock, clean sand and clean water mixture. Maximum shrinking of slurry mix shall not exceed 5% wet to dry.

h. Do not backfill until District’s Representative has approved installation and as-built drawings are up to date. Promptly install conduits after excavation has been done, so as to keep the excavations open as short a time as possible. Excess soil from trenching shall be removed from the site.

i. Install underground conduit, except under buildings, not less than 24-inches below finished grade in non-traffic areas and 30-inches below finished grade in traffic areas, including roads and parking areas. Not less than 48-inches below finished grade under public/ private transit system right of way and railroad right of way. Dimensions shall be measured to the top of the conduit.

j. Conduit crossing existing underground utilities shall cross below the bottom depth of the existing utilities. If the top portion of the existing utility depth below finish grade exceeds 72-inches and the specified separation and depths are maintained when crossing over the top of the existing underground utility, the conduit may cross above the existing underground utility.

k. Provide long radius horizontal bends (minimum radius of 36-times the conduit diameter) in underground conduits where the conduit is in excess of 100-feet long.

l. Conduits installed below grade and on grade below buildings, shall not be smaller than 0.75-inches. Conduits for circuits exceeding 600-volts shall not be smaller than 5.0-inches.

m. Underground conduits entering a building shall be sloped. The conduit direction of slope shall be away from the building, and shall prevent water in the conduit from “gravity draining” towards the building. The conduit slope “high point” shall originate from the building, out to the first exterior pullbox, manhole etc. exterior conduit termination “low point”. The minimum slope angle shall be a constant 8-inches (or greater) of fall for each 100-feet of conduit length.

n. Dewatering:
1) Provide pumping to remove, maintain and dispose of all water entering the excavation during the time the excavation is being prepared, for the conduit laying, during the laying of the conduit, and until the backfill at the conduit zone has been completed. These provisions shall apply on a continuous basis. Water shall be disposed of in a manner to prevent damage to adjacent property. Trench water shall not be drained through the construction. Groundwater shall not be allowed to rise around the pipe until joining compound has firmly set.
2) The DISTRICT’S Representative shall be notified 48 hours prior to commencement of dewatering.

6. Raceway/Conduits, which are installed at this time and left empty for future use, shall have 0.25-inch diameter polyvinyl rope left in place for future use. The pull rope shall be 500-pound minimum tensile strength. Provide a minimum of 5-feet of slack at each end of pull ropes.

7. Unless otherwise restricted by structural drawings and specifications, the maximum size conduit permitted in concrete slab on-grade, walls, ceilings and roofs constructed of masonry or concrete shall not be greater than 20% of the concrete/masonry thickness. Conduits installed in these locations shall not cross.
   a. Conduits shall not be installed in cast-in-place concrete floors.
8. Provide openings in building structures for conduit penetrations:
   a. New construction shall be provided with conduit sleeves, to provide conduit penetrations.
   b. Existing construction shall be drilled (core drill masonry and concrete) and provide conduit sleeves installed after drilling, to provide conduit penetrations.
   c. Where the structure penetrations for underground conduits penetrating through foundations will not comply with the (restriction/penetration) shown in the Contract

Documents, install the conduits below and clear of the foundation lowest point.

9. Conduit bends risers and offsets:
   a. The minimum bend radius of "factory or field" fabricated conduit bends shall not be less than the following. The bend radius shall be measured at the surface, inside radius of the conduit wall:
      1) FMC and LTFMC conduit - conduit minimum bend radius 12-times the conduit diameter.
      2) RMC and EMT conduit minimum bend radius - conduit for power circuits over 100 volts and less than 600 volts, 8-times conduit diameter. Conduit for power circuits over 600 volt, 12-times conduit diameter. Conduit for low voltage, signal and fiber optic circuits, 10-times conduit diameter.
      3) RNMC conduit - conduit minimum bend radius 36-times the conduit diameter. Under building reduce minimum bend radius to 10-times the conduit diameter. Conduit bends and offsets in RNMC with less than 36-times conduit diameter bend/offset radius, shall be RNMC PVC schedule 80 or PVC coated RGS.
      4) Conduits for utility company conductors. Conduit minimum bend radius shall comply with the respective utility company requirements.
   b. Bends and offsets in conduits shall be kept to an absolute minimum. The total summation of all bends and offsets permitted in a conduit segment, occurring between two conduit termination/ connection end points, shall not exceed the following, including conduit fittings:
      1) RMC and EMT conduit - 360 angular degrees
      2) FMC and LTFMC conduit - 180 angular degrees
      3) RNMC conduit - 270 angular degrees
   c. Each field fabricated conduit offset, bend and elbow which are not the standard product of the raceway/conduit manufacturer shall be mandrel tested. The test shall be conducted after the conduit installation is complete and prior to pulling-in any wire, in the same manner as for underground conduits.
   d. Factory manufactured angle connector conduit fittings shall be installed in exposed conduit locations only. Installation in locations normally concealed from view shall not be permitted. Not more than one (1) factory manufactured angle connector shall be permitted in any length of conduit between conduit termination end points.
   e. RNMC conduit risers from below grade shall be PVC coated RGS. Conduit risers, bends or offsets entering into a building shall be PVC coated RGS.
   f. If three (3) or more conduit-bends of the same conduit size and same conduit material type, installed, as part of the contract work, fail to comply with the required minimum conduit bend radius or conduit angular degree limits. The following corrective actions shall occur:
      1) The CONTRACTOR shall remove all the non-complying conduit bends and the respective wire in the conduit from the project site. Provide new conduit and wire, complying with the contract documents.

      2) Where the conduit bends similar to the non-complying conduit bends are installed concealed in walls, floors, above ceilings or below grade, the Contractor shall expose the conduit bends to allow visual observation.
      3) The CONTRACTOR shall remove the non-complying conduit bends and dispose off the project site. The CONTRACTOR shall provide new conduit bends and conductors complying with the contract documents.
      4) All the costs to correct the deficient material and work along with costs to repair the direct, indirect, incidental damages and contract delays shall be the sole responsibility of the CONTRACTOR and shall be included in the bid price.

10. Expansion joint, deflection joint and seismic joint fittings.
    a. Provide a conduit expansion fitting for each conduit length and conduit type as follows (Note - The installation of specified combination expansion/deflection fittings at seismic joints shall satisfy this spacing requirement also):

Conduit Type	Conduit	Fitting Length Spacing

1) RMC and EMT Exposed exterior locations 200-feet
2) RMC and EMT Interior weather protected locations 400 feet

b. Provide a conduit combination expansion/deflection fitting for each conduit, crossing the following elements:
1) At each building or non-building structure seismic joint.
2) At each building on non-building structure expansion joint.
3) At each conduit penetration of a "sound-rated" wall, floor or ceiling.

11. Provide two (2) locknuts and an insulated throat bushing at each metal conduit terminating at enclosures, including but not limited to outlet boxes, junction boxes, terminal cabinets, switchgear, transformers, switchboards, distribution panels and panelboards.
12. Provide metallic or plastic closure caps on all conduit ends during construction, until installation of conductors in the respective conduit.
13. Conduit run exposed, shall be run at right angles or parallel to the walls or structures. All changes in directions, either horizontally or vertically, shall be made with conduit outlet bodies as manufactured by Crouse Hinds, OZ or equal. Conduits run on exposed beams or trelliswork shall be painted to match surrounding surfaces.
14. Conduit exposed on roof:
a. Conduits installed exposed on roofs shall be limited on the project and be approved by Architect beforehand. When approved, they shall be installed on conduit sleepers. Place the conduit sleepers a maximum 5-foot on center along the entire length of the conduit; under conduit expansion/deflection fittings; under each junction box and within 24- inches of each conduit bend.
b. Provide a conduit support "C" channel continuous along the top length of the sleeper and rigidly bolted to the sleeper. Conduits shall be loosely fastened to each sleeper "C" channel with pipe clamps to allow for relative movement between the sleeper and conduit.
c. Conduits shall not block or interfere with roof hatches, doors, ventilation openings, dampers, equipment access panels/doors, roof water drainage.
e. Conduit sleepers shall be fabricated, MIFAB C-Port Rubber Support or MIRO Industries with Polycarbonate base, or equal. Sleeper length shall extend a minimum of 9-inches past the conduits attached to the sleeper, but in no case shall the length of the sleeper be less than 24- inches.
f. Provide a pad under each sleeper, sleepers shall not be installed in direct contact with the roofing. Sleeper pads shall extend a minimum of 6 inches past each side of the sleeper. The sleeper pad shall be semirigid mineral surfaced composition board, not less than 0.375-inch thickness, bituminous impregnated, manufactured for application on the specific roofing material. Remove roofing "ballast" (gravel) under pad, prior to installation of sleeper pad. Do not puncture roof membrane.
g. Position the "length" of the conduit sleepers' perpendicular to the roof slope, to prevent obstruction of roof drainage water flow. Where the conduit routing prevents placing the conduit sleeper parallel to the roof slope, provide two separate sleeper pads for the conduit sleeper, with a continuous 3-inches wide water drainage gap between the sleepers. Align the water drainage gap to allow unimpeded water travel along the roof slope drainage flow line between the pads.

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15. Rigid steel conduit or electrical metallic tubing shall not be strapped or fastened to equipment subject to vibration or mounted on shock absorbing bases.
16. RMC conduit threads:
a. Machine cut threads on RMC conduit required for field fabrication shall comply with NPS and ANSI-
B1.20.1.
b. The length of bare metal exposed during thread fabrication shall be completely covered by conduit couplings and fittings. Additionally, the thread length shall insure that conduit joints will reach "torque" tightness and become secure before conduit ends "butt" together and before conduit ends "butt" into the "shoulders" of other conduit fittings.

c. Running threads or right/left handed threads shall not be used to connect RMC.

17. RNMC conduit:
    a. Joints and fittings shall be solvent welded to RNMC conduit. Joints and fittings shall be watertight and airtight after fabrication.

18. Tighten each conduit fittings and fitting appurtenance, to the "torque" (allowable tolerance 5%) value recommended by the fitting manufacturer and applicable code. If three (3) or more conduit fittings are found to not be in compliance with the manufacturer's "torque"
    (tightness) recommendations, the following corrective actions shall occur:
    a. The CONTRACTOR shall tighten "re-torque" the defective fittings and all similar conduit fittings installed as part of the contract documents in the presence of the District's Representative.
    b. If the respective conduit fittings similar to the deficient "torque tightness" fittings are installed concealed in walls, floors, above ceilings or below grade, the CONTRACTOR shall expose the fitting, to allow retightening each similar conduit fitting to the manufacturers recommended "torque" values.
    c. All the cost to repair the direct, indirect, incidental damages and contract delays resulting from complying with these requirements shall be the sole responsibility of the CONTRACTOR and shall be included in the bid price.

19. Horizontal directional boring for underground conduit:
    a. Provide a directional guided horizontal "bore-hole" underground conduit installation where one or more of the following conduits occur:
        1) Continuous trenching excavation and backfill for conduit installation is not permitted by the contract.
        2) Where continuous trenching excavation due to the existing surface and below grade conditions and restrictions, is not possible or practical to excavate a trench.
    b. Provide "path-tracing" of the underground bore head, from the surface, along the entire horizontal bore length. Path tracing shall use electronic transmitters and receivers, continuously communicating the underground bore head locations and depth to the bore equipment operator. The directional boring system shall employ active tracking and directional position/steering control of the bore equipment drill head location. The active tracking system shall provide a portable receiver/transmitter unit for tracking the position of the moving drill head; a sensor "Sonde" unit on the drill head for tracking signals to the receiver /transmitter; and a drill head tracking data view display located at the boring equipment operator position to view the drill head position information sent from the portable receiver/ transmitter. As manufactured by SPX-Radiodetection Company or similar products.

    c. Provide vertical pilot excavations not more than 50-feet on center along the path of the bore-hole to intercept the horizontal bore-hole routing, provide excavations at the beginning and end terminals staging points of the horizontal bore-hole.
    d. Provide full-depth "shoring" of the vertical pilot excavations. Remove the shoring, backfill, compact and repair the excavations when conduit installation is complete.
    e. "Drilling-fluid" shall be used during "back-reaming" and "pullback", pumped through the drill pipe to the bore drill head.
    f. Directional guided horizontal drilling shall employ equipment specifically designed and manufactured for the process. The equipment manufacturer shall train bore equipment operating personal in the proper operation of said equipment.
    g. Locate the position, size, depth and identify all underground "cross-bore" existing underground utilities, pipes, structures and conflicts along the entire bore path of each underground bore, prior to initiating directional boring work. Notify respective agency for each "cross bore" potential crossing. Comply with the recommendations of the Cross Bore Safety Association (CBSA).
    h. Horizontal, directionally guided boring equipment, as manufactured by Ditch Witch;

Vermeer Manufacturing; or Case Corporation.

J. Conduit Seals
   1. Provide conduit seal fittings at each location where a conduit transitions or passes through the following areas and where indicated on the drawings:
      a. Refrigerated areas.
      b. Temperature control rooms including warming rooms, steam rooms, saunas etc.
      c. Classified hazardous material areas.
      d. Water intrusion areas.
   2. Provide conduit seals on each conduit entering a building from a below grade area located outside the building (i.e., basement, vault etc.) and connecting to the following types of equipment
      a. Transformers
      b. Panelboards
      c. Motor control centers
      d. Switchboards
      e. Switchgear
      f. Motors
      g. Terminal cabinets
      h. Terminal backboards
      i. Cable trenches
   3. Conduit seals shall be installed in locations where the fitting is visible and accessible.

K. Nailing Shields
   1. Provide “nail” shields where FMC conduit and conductors not installed in a conduit are installed through wood stud and wood frame construction. The nail shield shall provide a barrier resistant to “nailing” fasteners through the stud, and penetrating into the FMC and conductors.
   2. The nail shields shall be flat nominal 1.5-inch x 3-inches, 14-gauge steel, and hot dip zinc galvanized with “nailing spurs”.
   3. Provide nailing shields on the front face and rear face of each FMC penetration. The shield shall be centered on each penetration through the respective framing, stud framing blocking, and stud framing plates.

L. Conduit Bodies
   1. Conduit bodies shall be installed in exposed conduit locations only or above accessible ceilings.
   2. Conduit bodies shall be accessible for removing body cover and pulling wire through the conduit body.
   3. Conduit bodies shall not be installed inside enclosed walls.

M. Preparation of Reuse of Existing Conduits
   1. Prepare existing conduits shown to be reused as part of contract work as follows: Complete the required work prior to installing any conductors or cables in respective existing conduits.
      a. “Rod” out existing raceways to be used under this contact, with approved test and flexible mandrels to remove all obstructions to clear debris from inside conduits.
      b. Use test mandrels at least 12-inches long, 0.25-inches less than diameter of duct at center, tapering to 0.5-inches less than duct size at ends.
   2. If test mandrels cannot be pulled through raceways, CONTRACTOR shall perform the following to clear the existing raceways:
      a. Force rigid or semi-rigid rods through the raceways to clear the obstructions from one to both ends of the raceway.
      b. Force a power driven rotating router device through the conduit from one or both ends of raceways. Device shall incorporate small diameter cutting blades. Repeat the “router” process in incremental stages to a cutting blade diameter approximately ⅛-inch smaller than the raceway inside diameter.

3. After clearing the raceway of obstructions, pull a test mandrel or brush through the raceway to clear the remaining debris from the raceway.

3.04 WIRE AND CABLE

A. Branch circuit and fixture joints for #10AWG and smaller wire shall be made with UL-approved connectors listed for 600 volts, approved for use with copper and/or aluminum wire. Connector to consist of a cone-shaped, expandable coil spring insert, insulated with a nylon shell and two (2) wings placed opposite each other to serve as a built-in wrench or shall be molded one-piece as manufactured by 3M-"Scotchlok".

B. Branch circuit joints of #8AWG and larger shall be made with screw pressure connectors made of high strength structural aluminum alloy and UL-approved for use with both copper and/or aluminum wire as manufactured by Thomas & Betts. Joints shall be insulated with plastic splicing tape, tapered half-lapped and at least the thickness equivalent to 1.5-times the conductor insulation. Tapes shall be fresh and of quality equal to Scotch.

C. Use UL listed pulling compound for installation of conductors in conduits.

D. Correspond each circuit to the branch number indicated on the panel schedule shown on the drawings except where departures are approved by the DISTRICT'S REPRESENTATIVE or the DISTRICT'S Representative.

E. All wiring, including low voltage, shall be installed in conduit.

F. Control wiring to conform to the wiring diagrams shown on the mechanical drawings and the manufacturer's wiring diagrams.

G. All splices in exterior pull boxes and light poles shall be cast resins encapsulated.
   1. Power conductor splices - 3M Scotchcast Series 82/85/90; Plymouth or equal.
   2. Control and signal circuits 3M Scotchcast series 8981 through 8986, Plymouth or equal.

H. Neatly group and lace all wiring in panelboards, motor control centers and terminal cabinets with plastic ties at 3-inch on centers. Tag all spare conductors.

3.05 CHEMICAL GROUND ROD

A. General
   1. Install ground rod system in compliance with manufacturer's instructions.
   2. Install rods vertically. Where subterranean hard rock conditions prevent vertical installation horizontal "L" shape ground rod shall be installed.
   3. Where ground rod is installed in an indoors dry location set ground box flush with finish floor. Where ground rod is installed outdoors set the top of the ground box four inches above finish grade.
   4. Do not remove sealing tape from ground rod holes until time of installation in ground.
   5. Separate ground rods from all other grounding electrodes and from each other by not less than 12-feet horizontal distance.

B. Excavation
   1. Vertical installation bore a 12-inch diameter vertical hole in the ground six inches deeper than ground rod length.
   2. Horizontal installations excavate a 12-inches wide trench, slope rod and trench to insure end cap of rod is 2-inches lower than the elbow.

C. Backfill
   1. Surround the entire rod with a minimum of 10 inches of bentonite clay mixed with water at six times volume to form a paste. Approximately 14-gallons for each 50-pounds of clay. Remove any excavation liners from the rod excavation area.
   2. Install ground box and complete backfill.

D. Connect grounding electrode conductor(s) to ground rod.

3.06 CABLE RACKS

A. General

1. Provide cable racks in precast and cast-in place concrete pullboxes, manholes and cable trenches, and ensure that all cables, conduits, or conductors of line or high voltage, are neatly assembled and are a minimum of 4" from the bottom of the boxes.

3.07 TESTING

A. Testing Conduit and Conduit Bends

The CONTRACTOR shall demonstrate the usability of all underground raceways, and field fabricated conduit bends installed as part of this contract.

1. A round tapered segmented semi-rigid mandrel with a diameter approximately ¼-inch smaller than the diameter of the raceway, shall be pulled through each new raceway.
2. The mandrel shall be pulled through after the raceway installation is completed. Conduits which stubout only, may have the mandrel pulled after the concrete encasement is completed, but prior to completing the backfill.
3. DISTRICT'S REPRESENTATIVE shall witness the raceway testing for usability. A Representative of the Respective Utility Company shall witness the raceway testing where applicable.
4. CONTRACTOR shall repair/replace any conduit and conduit bend provided under this contract which will not readily pass the mandrel during this test.

END OF SECTION

SECTION 26 05 43

PULLBOXES

PART1 GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other sections for work related to those other sections and required to be included as work under this section.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit product data sheets for all racks, hooks, supports, ladders, covers, grounding, manholes, vaults, pullboxes, joint sealing compound etc.

B. Submit detailed shop drawings including dimensioned plans, elevations, details, structural calculations signed by a California State registered Structural ENGINEER and descriptive literature for all component parts.

PART 2 PRODUCTS

2.01 GENERAL

A. Each concrete precast section shall be identified by having the manufacturer's name and address, along with respective section weight cast into an interior face or permanently attached thereto. Associated Concrete Products, Jensen Precast Products, Brooks Products or equal.

B. Structure Construction
   1. The precast steel reinforced concrete structure walls, floor and roof shall safely sustain the loads and pressure resulting from vertical and lateral earth loading and vehicular loading. Based on the following criteria:
      a. Minimum earth density shall be 120 lbs./cu.ft.
      b. Minimum equivalent fluid pressure for lateral pressure due to earth shall be 85 lbs./sq.ft. undrained earth conditions, minimum safety factor for buoyancy shall be 1.25.
      c. Vehicular load rating shall be H-20 in compliance with latest AASHO specifications.
      d. Design shall be based on maximum depth of fill over the structure as indicated on the drawings, but not less than 36 inches.
      e. Design and details shall comply with minimum ACI 318-63 code requirement. Minimum concrete 28 day cure strength shall be 3,000 psi.
   2. Precast structure shall be designed to withstand forces due to additional inward load of 4,000 pounds (working load) with safety factor of two (2), acting perpendicular to the surface at any pulling iron.
   3. Structures shall be single piece or horizontal multi-section construction as required for field installation conditions. Multi-sections shall interlock with "Tongue and groove" joint mating surfaces to insure a rigid assembly.
   4. All structure precast joints shall be sealed with preformed cold field applied plastic joint sealing compound. Joint sealing compound shall not leak, sag or flow at the joints with 10 psi water pressure applied for 24 hours. Chemically resistant to acid, alkali's and saturated hydrogensulfide.
   5. Each precast structure section shall have suitable knockouts or openings in the vertical walls for the duct banks and conduits entering the structure. Provide a 1 inch diameter

knockout in each corner of the floor slab, 6 inch from adjacent walls, for installation of ground rods.

C. Intercept Manhole/Pullbox Structures
   1. Intercept type manhole/pullbox structures shall comply with the requirements of non-intercept manholes and pullboxes, respectively. Plus the additional requirements listed below.
   2. Manholes/pullboxes shown to be installed at the same location as replacement for existing manhole/pullbox shall be custom fabricated "intercept" multi-section type.
   3. The structure shall be provided with multiple, vertical and horizontal custom fabricated sections for fitting around existing manholes/conduits/duct banks/conductors entrances into the structure during manhole installation without disturbing existing manholes/pullboxes. The structures shall allow placement of the structures without disconnecting or disrupting existing circuits during the installation. The structure walls shall be slotted to fit around existing concrete encased conduit entrances.
   4. Provide cast-in-place concrete steel reinforced foundation/footings and floor for the intercept structure. The foundation shall be installed prior to removal of existing manhole/ pullbox. The floor shall be installed after removal of the existing manhole/pullbox structure. The foundation/footing and floor shall be designed, and engineered as part of precast structure.
   5. The structure foundation/footings shall be "keyed" to match keying of manhole precast wall sections.

2.02 PULLBOXES

A. Pullboxes shall have deep recess conduit knockout concrete extensions at two opposite end walls. Additional shallow recess knockouts shall be provided on the other two walls for conduit entrances.

B. Pullboxes shall be provided with a minimum of one precast concrete 6 inch extension grade ring "tongue and groove" matting surfaces to insure rigid assembly.

C. Pullbox sizes shall be as indicated ori drawings but in no case less than required by applicable codes. Minimum depth of the pullbox shall not be less than 42 inch.

D. The pullbox floor sump shall extend through the concrete floor into the gravel bedding, below the pullbox.

2.03 COVERS AND FRAME ASSEMBLIES

A. Traffic rated per AASHO for H20 loading.

B. Pullboxes
   1. Hot dip galvanized steel single piece flush fitting with threaded flush hold down, slotted head, stainless steel studs.
   2. Topping frame shall be hot dip galvanized steel angle frame where the pullbox is installed in paving or concrete work.
   3. Top ring frame shall be armor band type where the pull box is installed in exposed earth or landscaping.
   4. Cover openings larger than eight (8) square feet of surface area, shall be provided with "split" two (2) piece cover type. Each "split" cover shall be hinged open-close with Torsion-Spring type cover, to assist in the ease of opening and closing the cover.
   5. Cover openings eight (8) square feet or smaller surface area shall be single piece covers.

C. Covers shall be permanently marked in the cover metal as follows:
   1. "E" or "Electric" for covers on structures containing power circuits under 600 volts and "HV" or "High voltage" for covers on structures containing power circuits over 600 volts.
   2. "Signal" for covers containing signal circuits.

2.04 CABLE RACKS

A. Cable racks, installed on the vertical walls of the structure, including hooks and porcelain insulator cable cradles, shall be sufficient to accommodate the cables and splices.

B. Vertical racks shall be installed on all walls of the structure a minimum of 24-inches on center within 6-inches of floor and top of wall. A rack shall be installed within 18-inches of each corner of each wall. Additional racks spaced equally on each wall shall be installed, spacing between vertical wall racks shall not exceed 24 inches.

1. Wall racks shall be slotted to accept removable hooks and lock hooks into place.
2. Non-metallic, 50 percent (minimum) glass reinforced nylon or non-metallic material of the same characteristics.
3. The installed cable racks, cable support hooks with arms and wall anchor bolts shall support the following minimum loads for each hook/arm, with a 2000 percent minimum safety factor. Based on multiple hook/arms located not less than 9-inches on center along the entire vertical length of the support rack:

Hook/Arm Length	Minimum Weight Each Hook/Arm Supported	Maximum Allowable Hook/Arm Deflection
a. 8-inch	450 pounds	0.25-inch
b. 14-inch	350 pounds	0.37-inch
c. 20-inch	250 pounds	0.37-inch

(Based on load, concentrated 1-inch from the end of each hook/arm.

4. Racks shall be bolted to the precast and cast-in place structure walls, within 3-inches of each rack end and not less than 9-inches on center. Provide cast-in place or after set drilled expansion concrete anchors.

2.05 PULL-IN-IRONS

A. Pull-in-irons shall be a galvanized steel bar bent in a "U" shape, and cast in the structure walls and floors.

B. A floor pull-in-iron shall be centered under the manhole entry ring in the structure floor.

C. Pull-in-irons shall not be less than 6 inches above or below, in the opposite wall from each knockout panel for conduiUduct entrances.

D. Pull-in-irons shall project from the structure wall into the structure approximately four inches.

2.06 DRAINAGE SUMPS

A. Provide drainage sump with cast iron metal grate in the floor of each structure. Minimum diameter of 12-inches by 4-inches deep. Provide a removable cast iron grate over the sump.

PART 3 EXECUTION

3.01 EXCAVATION

A. Excavate for installation of precast structures removes excess excavated material from the site. Saw cut existing paving and concrete as required for excavation.

B. Provide a minimum of 6-inches deep bedding base of crushed rock 3/8-inch - Y:!-inch size in the bottom of the excavation. Bedding shall be level and well compacted by a minimum of four passes with a plate type mechanical vibrator.

C. Back fills and compact earth around precast structure after installation of the structure to 90-percent minimum compaction in 12-inch lifts. Replace paving concrete, landscaping above structure to match existing.

3.02 INSTALLATION

A. Install precast structures per manufacturer recommendations to provide a dry watertight installation. Set cover flush with existing grade or finish surface. Where precast structure is installed in pedestrian walkway or vehicular traffic way with a sloping finish grade. Slope cover to match existing finish surface slope.

B. Install structures to avoid surface water drainage flow lines, and existing utilities.

C. Exterior concrete walls tops and bases of precast structure shall be damp-proofed with two coats of a bituminous damp-proofing material, minimum finish thickness 4-mil.

D. Connections to Precast Structure
   1. Lines connecting to precast structures shall be constructed to have a cast in place concrete tapered section adjacent to the structure and extending a minimum of 48 inch out from the structure to provide shear strength.
   2. Precast structure shall be constructed to provide for keying the concrete envelope of the conduiUduct line into the wall of the structure. Mechanical vibrators shall be used when this portion of the envelope is poured to assure a seal between the envelope and the wall of the precast structure.

E. Entrances of conduits/ducts shall terminate with endbells inside the precast structure. Slope conduit entrances into manhole to insure top of conduit entrances into manhole are a minimum of 6-inches below manhole ceiling. Maximum conduit slope shall not exceed 1-inch per "running" foot of conduit.

F. Manholes and pullboxes shown to intercept existing conduit, remove portion of existing conduit approximately 4-feet back from manhole wall, regrade and excavate conduit entrance and extend existing conduit into manhole or pullbox to match existing conduit quantity and size. Provide "horizontal, split" conduit and split conduit coupling to extend existing conduit into manholes and pullboxes.

3.03 GROUNDING

A. Provide 10-feet long by 0.75-inch diameter copper clad, steel, driven ground rods through the floor of the precast structure. Provide a minimum of two ground rods in opposite corners in manholes and vaults, one ground rod in pullboxes. Ground rod shall extend 6-inches above the floor line. Where rock bottom is encountered, bury ground rod in horizontal trench with projection into precast structure. Seal off openings around ground rods.

B. Ground permanently and effectively together all metal equipment cases, metallic, cable racks, ladders, etc., with #4 bare copper bonding conductor. Provide U.L. compression bonding fittings at each ground connection.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other specification sections and drawings for related work required to be included as work under Division 26.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Provide schematic "ladder type" logic control wiring diagrams and "point-to-point control wiring diagrams showing control and protective systems interlocks.

B. Provide nameplate engraving schedule.

C. Submit full-scale time/current transparencies on log/log paper for all fuses, circuit breakers, ground fault system devices, and relays. Additionally, provide software to generate time/current curves of each circuit protection device.

D. SHORT CIRCUIT, COORDINATION AND ARC-FLASH
   1. Perform and submit engineered settings for each equipment location, fuse and circuit breaker device, showing the correct time and current settings to provide the selective coordination within the limits of the specified equipment, per the latest applicable standards of IEEE and ANSI. Provide electrical system short circuit fault analysis, both 3-phase line- to-line and 1-phase line-to-ground calculations as part of the coordination analysis recommendations. Provide Electric ARC-FLASH calculations as part of the coordination analysis recommendations.
   2. The information shall be submitted in both tabular form and on time current log-log graph paper, with an engineering narrative. Written narrative describing data, assumptions, analysis of results and prioritized recommendations, six (6) copies.
   3. The goal is to minimize an unexpected but necessary electrical system outage and personnel exposure to the smallest extent possible within the fault occurrence location, using the specified contract equipment. Shall comply with, but not limited to:
      a. IEEE-242, Recommended Practices for Protection and Coordination of Industrial and Commercial Distribution.
      b. IEEE-399, Recommended Practice for Industrial and Commercial Power System Analysis.
      c. IEEE-1584, Guide to Performing ARC-FLASH Hazard Study.
      d. CEC/NEC
   4. Electrical equipment including switchgear, switchboards, electric panels and control panels, motor control centers, combination motor starters, transformers, disconnects, etc., shall each be labeled by the manufacturer with “Electric-ARC-FLASH” warning signs. The signs shall explain a hazard to personnel may exist if the equipment is worked on while energized or operated by personnel while energized. The sign shall instruct personnel to wear the correct protective equipment/clothing (PPE) when working “Live”, or operating “Live” electrical equipment and circuits.

E. Factory Tests: Equipment tests - ANSI C37.20. Certified copies of design tests, production tests, and conformance tests of the equipment shall be submitted and review comments shall

be received before delivery of equipment to the project site. In lieu of the above tests, a report of these tests previously performed on identical units of each rating will be acceptable.

1.03 APPLICABLE STANDARDS

A. The switchboard and switchgear equipment shall be designed, tested and assembled to comply with ANSI, IEEE, and NEMA and UL.

B. Seismic Earthquake and wind loading withstand, testing and certification (ADDITIONAL REQUIREMENTS).
   1. The complete switchboard/switchgear assembly; including circuit protection devices, meter, housings/enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested.
      a. Wind loading all outdoor equipment locations.
      b. Earthquake seismic requirements of CBC/IBC Seismic withstand all indoor and all outdoor equipment locations.
   2. Shall withstand, survive and maintain continuos non-interrupted energized operation during the seismic event occurrences and wind event occurrences. Continued normal energized operation after the wind event and seismic event occurrences have abated.
   3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation. Acceptance test seismic qualification of proposed switchboard and/ or switchgear shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
   4. Provide three (3) dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading not less than as follows and as required by AHJ:
      a. 100MPH-West coast states USA, California, and Hawaii.
      b. 150MPH-East coast states USA, Gulf coast states USA and Alaska state.
      c. 90MPH-all other USA locations.
   5. Seismic test shall be performed by a third party independent test laboratory. Wind analysis and seismic Testing and reports shall be certified, signed and “stamped” by PE Professional Engineer licensed and in good standing in the State, Civil Engineer or Structural Engineer.

C. Equipment components/devices, switchboards, and/or switchgear shall be manufactured by: General Electric; or Cutler-Hammer; or Square–D; or Siemens.

PART 2 - PRODUCTS

2.01 BUSSING

A. Horizontal and vertical busses shall be full lengths in each equipment section. Buses shall have a minimum short circuit fault withstand rating equal to available fault current indicated on drawings, plus a 25% additional capacity (safety margin). However, in no case shall the rating be less than 50,000 amperes, symmetrical.

B. Provide interconnected full capacity neutral bus in each section with the same ratings and construction as the phase busses.

C. Provide interconnected ground bus in each section.

D. Provide space and all hardware and mounting attachments for future devices as indicated on the drawings.

E. Main horizontal phase and neutral bussing shall be full capacity in all equipment sections. The through bus of the end distribution section shall be extended and pre-drilled to allow the addition of future sections.

F. Vertical riser buss may be tapered, to not less than one third the ampacity rating of the main horizontal buss; but in no case shall the vertical buss be of less capacity than the sum of the

frame size ampacities of overcurrent devices mounted in the respective sections including any indicated spares and spaces.

G. The equipment bussing shall be of sufficient cross-sectional area to meet UL Standard 891 on temperature rise Bus shall be copper with silver plated bus joints or extruded aluminum with tin plated bus joints. The through bus shall have provisions for the addition of future sections. The through bus supports, connections and joints are to be bolted with grade 5 hex head bolts and Belleville washers to minimize maintenance requirements.

2.02 CIRCUIT BREAKERS

A. General
   1. Circuit protective devices as indicated on the drawings. All devices shall have a short circuit interrupting capacity not less than the maximum available fault current at the circuit breaker and as indicated on the drawings, plus a 25% additional capacity (safety margin). However, in no case shall the circuit breaker interrupting capacity be less than 30,000 ampere symmetrical interrupting for 480/277 volt devices and 42,000 ampere symmetrical for 240 volt or 208/120 volt devices.
   2. Provide padlock-off devices on each device. Breakers shall provide automatic time over-current and instantaneous circuit protection. Shall be suitable for use as “Main” service disconnect, “Feeder” and “Branch-Circuit” functions.
   3. Circuit breakers shall employ a self-powered stored energy, quick make-quick break, and trip free operating system on each phase, with common trip. Circuit breakers shall not trip in the event of short term or long term electrical power failure. Dead front cover accessible close-open controls, monitors and visual indicator flags.
   4. Circuit breakers noted as "100%" on the drawings shall be tested and rated to carry the breaker full rated (100%) ampere load continuously including the assemblies the circuit breakers are installed into.
   5. Provide conductor lugs for circuit protection devices to accept conductor temperature rating, sizes and quantities shown on drawings. Circuit protection devices shall be UL-listed suitable for normal and reverse feed.
   6. Provide auxiliary contacts on circuit breakers. Auxiliary “DRY” contacts shall provide supervised remote monitoring of “Open-Close-Trip” circuit breaker status. Typical for circuit breakers supplying the following types of connected electrical loads.
      a. Fire alarm equipment and devices.
      b. Mass-evacuation equipment and devices.
      c. HVAC smoke control and smoke evacuation equipment.
      d. HVAC fire/smoke electrically operated dampers.
      e. Intrusion detection and access control equipment and devices.
      f. Elevators and escalators.
      g. Fire sprinkler pumps.
   7. Plug-in communications port for circuit breaker portable test instrument connects.
   8. Circuit breaker data monitoring and communications:
      a. The circuit protection devices shall monitor, communicate and report circuit voltage, ampere, power, and harmonic parameters for the respective connected circuit. The circuit protection device monitor and communication parameters shall be the same and compatible with the specified “METERING” devices.
      b. Additionally the circuit protection devices shall monitor and communicate the respective device status as follows:
         1) Open/close/trip device status
         2) Ground fault trip status (where applicable)
      c. Provide circuit breaker data monitoring and communications for each of the individual feeder protection devices and main protection devices located in switchgear and switchboards, rated 400 ampere or greater trip rating.

d. The respective “METER” display selection control functions shall provide selection and display of all information monitored and communicated by individual protection devices on the respective meter alphanumeric display.

9. Circuit breakers shall be Power Circuit Breaker type, Insulated Case Circuit Breaker type or Molded Case Circuit Breaker type. Time/current and instantaneous characteristics and selection of circuit breaker type shall comply with the recommendations in the coordination study and insure optimal code mandated time/current and instantaneous coordinated sequential tripping throughout the electrical system.
   The contract document intent requires providing the selection and use of the circuit breaker types and performance characteristics for time/current and instantaneous trip coordination during electrical circuit overload conditions and during electrical short circuit fault conditions. Combined with the specified circuit breaker protection time/current performance characteristics.
   a. Insulated Case Circuit Breaker type-ICCB:
      1) NEMA-AB1 and AB3, comply with latest revision.
      2) UL-1087, UL-489 and IEC-60.947, comply with latest revision.
      3) 5Hz AC closing and 3Hz AC trip and clear.
      4) Hybred combination of Molded Case Circuit Breaker type and Power Circuit Breaker type circuit breakers. ICCB enclosed insulated housing and limited internal maintenance access.
      5) Two-step stored energy close mechanism.
      6) Extended function on-off instantaneous trip selection.
      7) Push-to-trip button.
      8) Mechanical operations counter.
   b. Molded Case Circuit Breaker type-MCCB:
      1) NEMA-AB1 and AB3, comply with latest revision.
      2) UL-1087, UL-489 and IEC-60.947.2 rated devices, comply with latest revision.
      3) 5Hz AC closing and 3Hz AC trip and clear.
      4) Sealed enclosed housing.

B. Protection performance requirements for circuit breakers conforming to one or more of the following applications:
   600 Ampere or larger frame size.
   Larger than 400 Ampere trip.
   Service entrance in main switchboard or switchgear.
   Noted as Main or Main Circuit breakers on the drawings.

1. Circuit breaker shall employ current sensors and solid-state static digital electronic automatic trip system. Three phase, or single-phase operation as noted on the drawings. Current carrying components shall be completely isolated from the static trip units. The trip unit shall be independent of external power sources. Circuit breakers shall be rated for reverse connection.
2. Circuit breaker solid state digital trip control functions shall provide the following time/ current curve shaping field adjustable features;
   a. Adjustable ampere setting to vary the long-time continuous current carrying capacity, minimum range of 80% through 100% of full load trip rating.
   b. Adjustable long-time delay setting to vary the time the breaker will trip under sustained overload conditions. Minimum of three (3) settings, "minimum - intermediate - maximum".
   c. Adjustable short-time pickup to vary the level of high current the breaker can carry for short periods of time, minimum range of two (2) times through eight (8) times of ampere setting.
   d. Adjustable short time delay to vary the time of the short-time pickup. Minimum of three (3) settings "minimum-intermediate-maximum".
   e. Short time "I^2t" switch to allow a current-squared multiplied by time ramp function in the short-time system. Two (2) position setting "in-out".

f. Adjustable instantaneous pickup to vary the breaker ampere setting for immediate (instantaneous) interruption of severe overloads (short circuits). Adjustable minimum range of two (2) times through nine (9) times of circuit breaker ampere sensor rating. Instantaneous selective override trip setting shall also include “on-off” function. When “off”:, or “override” is selected, shall then function with the adjustable short time delay and adjustable short time pick-up (Note where the coordination study requires a higher instantaneous setting, change the specified adjustable instantaneous trip to fixed instantaneous trip at fifteen (15) times the breaker ampere sensor setting also with on-off function).

g. Individual fault trip indicators (flags) shall provide local indication on the breaker for overload and short circuit (and ground fault where applicable) conditions.

h. Provide quantity of one, manufacturer’s standard test set for solid state trip circuit breakers.

C. Protection performance requirements for circuit breakers conforming to one or more of the following applications:

Smaller than 600 ampere frame size.

400 ampere and smaller trip.

Larger than 100 ampere frame size.

Larger than 100 ampere trip.

1. Circuit breaker shall employ current sensors and solid-state static digital electronic automatic trip system. Time/current curve shaping field adjustable features
2. Solid state digital trip breakers shall conform to the requirements described above for solid state breakers larger than 400 ampere trip. However, only the following field adjustments are required;
   a. Long-time ampere setting adjustable minimum range of 80% through 100% of full load trip rating.
   b. Short time pickup adjustable minimum range of two (2) times through eight (8) times of the ampere setting.
   c. Fixed or field adjustable instantaneous trip (depending on the results of the coordination study).

D. Performance requirements for circuit breakers conforming to the following applications:

100 ampere frame size and smaller.

100 ampere and smaller trip.

1. Circuit breaker shall be fixed or adjustable instantaneous current trip with thermal-magnetic trip or with solid-state static digital electronic automatic time/over current automatic trip (depending on the results of the coordination study).

E. Current Limiting Circuit Breakers (CLCB)

1. Protection performance requirements for circuit breakers conforming to the following applications:

600 ampere and smaller trip and identified as current limiting (CLCB) in the contract documents.

   a. Current limiting circuit breakers shall be supplied in integral fully enclosed insulating housing construction and shall consist of a common trip, thermal-magnetic or solid state static digital trip conventional circuit breaker (Depending on the results of the coordination study), with an independently operating limiter section in series with each pole.
   b. The conventional breaker section shall have an over center, trip-free, toggle-type mechanism with quick-make, quick-break action and positive handle indication. A button shall be provided on the cover for mechanically tripping the circuit breaker. The current limiting breaker shall have permanent trip units containing solid state static digital trip or individual thermal and magnetic trip elements, in each pole. Calibrated for 40-degrees C ambient temperature. The limiter section shall consist of current limiting

elements on each phase, electrically coordinated with the conventional circuit breaker trip elements. The contacts of the limiter section shall be electro-magnetically and electrodynamically opened and held open until interruption is complete.

c. Current and Energy Limitations: On high-level fault currents the limiter portion of the circuit breaker shall operate to limit the rise of fault current. Integral resistance shall be introduced into the faulted circuit to dissipate and limit let-through energy and to provide a voltage transient-free interruption at near unity power factor. The Let-through short circuit fault current and energy levels shall be less than that permitted by Underwriters Laboratories to a value less than I^2t of a half cycle wave of the symmetrical prospective current. The CLCB limiter shall limit the asymmetrical short circuit fault current below the equipment symmetrical short circuit fault current.

d. On fault currents below the threshold of current limitation, the normal non-limiter breaker section shall provide conventional time /current overload and short circuit fault protection.

2. Protection performance requirements for circuit breakers conforming to the following applications:

Trip ratings over 600ampere through 5000 ampere or less. Identified as current limiting (CLCB) in the contract documents.

a. Integrally fused circuit breaker integrated with solid state static digital electronic automatic trip. Combined standard circuit breaker providing overload-short circuit protection within its interrupting capacity and ON-OFF switching function and on each phase current limiters internally mounted on the load side of the circuit breaker, of such ratings that their time current limiting characteristics will coordinate with the time current tripping characteristics of the circuit breaker elements.

b. The coordination shall result in the interruption by the circuit breaker alone of fault level currents up to the interrupting capacity of the circuit breaker and interruption by the current limiter in conjunction with the circuit breaker of fault level currents above the interrupting capacity of the circuit breaker.

c. A removable cover shall be provided over the current limiter section of the integrally fused circuit breaker. The current limiter housing covers shall be interlocked with the breaker tripping mechanism to insure the breaker will trip upon removal of the cover. The cover shall be interlocked with the breaker to insure the circuit breaker cannot be turned to the ON position with the cover removed. Current limiters shall have a spring loaded plunger which, when the limiter blows, is released to actuate the circuit breaker common trip bar mechanism opening all breaker poles simultaneously.

d. The limiters shall be individually interlocked with the breaker element tripping mechanism to insure the limiter cannot be inserted until the breaker is in the OFF position. The circuit breaker and limiters shall be interlocked to insure the circuit breaker cannot be closed if a limiter is either missing or has blown.

e. Fuse limiters shall be individually removable from the circuit breaker housing.

f. The circuit breaker shall be ambient temperature compensating. The circuit breaker shall be provided with thermal magnetic or solid state static digital trip (depending on the coordination study).

g. The integrally fused circuit breaker shall be capable of interrupting available short circuit currents up to 200,000 RMS symmetrical amperes at voltage up to 600 VAC.

h. Ratings, clearances and performance of the integrally fused circuit breaker shall be in accordance with applicable standards of NEMA, IEEE and UL.

2.03 SWITCH AND FUSE FEEDER PROTECTIVE DEVICES

A. Fusible Switches: Quick-make, quick-break type with rejection clips for use with Class "R" fuses current limiting fuses (CLF). Switches with ratings up to and including 100 ampere at 240-volts shall be twins mounted. Switches rated through 60 amperes and 480 volts shall be twins mounted. Shall be UL listed suitable for normal and reverse feed. Switches shall be removable from front of switchboard without disturbing adjacent units or switchboard bus structure.

B. Fuses shall be time delay current limiting types, UL Class RK-1 unless otherwise indicated on the drawings. Provide one (1) spare set of fuses of each size and type in each switchboard.

C. Provide auxiliary contact on switch for remote status (on-off) signaling and monitoring. Provide conductor lugs to accept conductor temperature rating, sizes, and quantities shown on drawings.

2.04 GROUND FAULT PROTECTIVE SYSTEM AS FOLLOWS:

A. One control power transformer rated 480/120 volts of suitable capacity for shunt tripping of the main circuit breaker and subfeed circuit breakers as indicated on the drawings. Fuse transformer on the 480-volt side.

B. Ground sensor current transformer for each indicated ground fault relay, zero sequence type with integral test winding for each circuit indicated on drawings (The 3-phases and neutral conductor shall be brought through the current transformer window per manufacturer's recommendations). Shall be UL-listed suitable for normal and reverse feed.

C. One ground break, solid-state relay, and monitor and test panel for each device indicated on the drawings. Pick-up adjustment shall be continuous 100 through 1200 ampere; time adjustment shall be continuous from instantaneous through sixty (60) cycles. Monitor panel shall indicate relay operation and provide means for system testing with or without interruption of service, and shall not permit system to be inadvertently left in an inactive or off state. Provide resettable trip indicators.
   1. Ground fault system shall provide selective trip coordination with other upstream/down-stream ground fault and phase over current circuit protection devices as determined by the coordination study.
      a. Ground fault protection devices shall incorporate adjustable time/current trip settings.
      b. Ground fault protection devices shall incorporate adjustable inverse time and very inverse time adjustable/selective settings.

D. The ground fault system may be integrated into each circuit breaker with solid state trip units, in lieu of the separate specified ground fault relay and monitor panel system. The solid state circuit breaker ground fault system shall provide the identical specified operational features of the described separate system.

E. Each circuit breaker 100 ampere and larger, located in the main switchboard(s) and distribution switchboard or main switchgear where the main bus is larger than 800 ampere and operating above 240 volt phase-to-phase, shall be provided with ground fault system whether or not shown on the drawings. Provide all interconnecting control power and interlocking wire in switchboards/switchgear and between switchboards/switchgear for an operational system.

2.05 MAIN SWITCHBOARDS

A. Switchboard shall be floor-mounted, dead-front, dead-rear type, front and rear aligned, self-supporting, consisting of one or more vertical sections with bussing, circuit protective devices, instrumentation, auxiliary devices and control wiring as indicated on the drawings and as specified herein.
   1. Shall be utility and service entrance rated and approved.
   2. Switchboards shall employ mounting configuration for circuit protective devices as follows:
      a. Group-mount, fixed position, non-drawout switchboards. Front access only, shall not require rear access. Typical for all circuit protective devices or as indicated on drawings.
   3. Switchboards shall employ circuit breakers types and circuit protection devices as follows:
      a. All Main circuit breaker of all frame sizes – ICCB type circuit breakers.
      b. 800 ampere and larger frame size Feeder circuit breakers, ICCB type circuit breaker.
      c. Smaller than 800 ampere frame size Feeder circuit breakers, ICCB type; or MCCB type circuit breakers.

d. CLCB type circuit breakers. CLCB circuit type only where noted on the drawings.
e. CLF with switch and fuse type. CLF with switch and fuse type only where noted on the drawings.

4. Transient Voltage Surge Suppressor – TVSS
   a. Provide a 3-phase, 5-wire TVSS in the switchboard, with 30-ampere 3-pole subfeed circuit breaker.
   b. See Specifications Section 16050 for TVSS additional requirements.

B. Switchboard shall be designed, built and tested in accordance with applicable portion of the latest editions of NEMA PB-2, Underwriters Laboratories No. UL-891 and the National Electrical Code. Rated for service-entrance operation.

C. Switchboard sections configuration
1. Floor standing self-supporting, of the universal frame type using dieformed, 12-gauge steel members bolted and welded together.
2. Provide removable side and rear plates with formed edges all around.
3. Provide ventilation openings required for maintaining nominal operating temperature.
4. Provide removable steel cover plates for all usable device spaces. Provide lifting means and provisions for moving by means of rollers or skids to installation location.
5. Bolt individual sections together to form a single rigid switchboard assembly.
6. Provide full height, hinged, vertical wireway metal covers, on each vertical wireway, of each distribution section of the switchboard.
7. Typical for all switchboards, distribution switchboards and switchgear.

D. Switchboard shall include, but not be limited to, the following:
1. Underground pull section as required by the serving utility incoming service.
2. Metering facilities as required by the serving utility.
3. Current transformer space.
4. Main disconnects devices.
5. Distribution and feeder circuit protective devices.
6. District metering (where indicated on drawings).
7. Bussing, incoming utility compliant and outgoing distribution.
8. Transient Voltage Surge Suppressor Protection (TVSS).

2.06 DISTRIBUTION SWITCHBOARDS

A. Switchboards shall be floor mounted, dead-front, dead-rear type, front and rear aligned, self-supporting, consisting of one or more vertical sections with bussing, group mounted circuit protective devices, instrumentation and control wiring as indicated on the drawings and as specified herein. Switchboards shall comply with UL Standard #UL-891 and NEMA-PB2.
1. Distribution switchboards shall be service entrance rated and approved, when located in a building separate and remote from the main service entrance switchboard.
2. Distribution Switchboards shall employ circuit breaker types and circuit protection devices as follows:
   a. All Main circuit breakers of all frame sizes - ICCB type circuit breakers.
   b. 800 ampere and larger frame size Feeder circuit breakers, - ICCB; or MCCB type circuit breakers.
   c. Smaller than 800 ampere frame sizes Feeder circuit breakers - ICCB; or MCCB type circuit breakers.
   d. CLCB type circuit breakers, only where noted on the drawings.
   e. CLF with switch and fuse type. CLF with switch and fuse type only where noted on the drawings.

B. Distribution switchboards shall include but not be limited to the following:
1. Main disconnect device (where indicated on drawings).
2. Feeder protective devices.
3. District metering (where indicated on drawings).

4. Bussing.
5. Transient Voltage Surge Protection (TVSS).

C. Switchboard sections
1. Floor standing, self-supporting, of the universal frame type using dieformed, 12 gauge steel members bolted and welded together.
2. Provide removable side and rear plates with formed edges all around.
3. Provide ventilation openings required for maintaining nominal operating temperature.
4. Provide removable steel cover plates for all usable device spaces. Provide lifting means and provisions for moving by means of rollers or skids to installation location.
5. Bolt individual sections together to form a single rigid switchboard assembly.
6. Provide full height, hinged, vertical wireway metal covers, on each vertical wireway, of each distribution section of the switchboard.

2.07 MISCELLANEOUS INSTRUMENTS

A. Instrument and Control Transformers: ANSI C57.13 and NEMA ST20 as applicable. Transformers shall be specifically designed for use on respective protective relay or metering schemes utilized.

B. Current transformers meter/relay grade shall be multiratio tap, tap setting as indicated on drawings, (minimum of three (3) field adjustable tap settings) with 5 amp secondary, insulation class, 600 volt, 60Hz, single ring type, and shall have an accuracy classification of 0.3 with the burden of B.01, B.02 and B.03.

C. Control and transfer switches shall be of the rotary, oil-tight multiposition, cam-operated, multi-stage type, with dust cover and silver-to-silver contacts rated 600 volts, 20amp and adequate for the duty performed in excess of 10amp. Equip each switch with engraved plastic escutcheon nameplate identifying its function and position.

2.08 CONTROL WIRING

A. Terminal blocks with barriered terminals for each connection shall be provided for all control wiring terminator points. Control wiring shall be run in horizontal and vertical, isolated, internal metal wireways and shall be carried across hinges in laced bundles. Wire terminators shall be crimp-on type spade terminal

B. Secondary control wiring shall be a minimum of 14AWG stranded copper type SIS 600-volt insulation.

C. Control circuits shall have circuit number tags at each termination or break in the wire to match circuit numbers on terminal strips and control wiring diagrams.

2.09 WEATHERPROOF EQUIPMENT

A. Equipment indicated as weatherproof (W.P.) or outdoors should be NEMA 3R, non-walk-in, tamper resistant construction. Provide full height hinged doors with provisions for padlocking the doors in the closed position.

B. Provide a nominal 300-watt sealed, resistance type, anti-condensation heater in each equipment section. Heaters shall be controlled automatically by Thermostats and Humidstats. A circuit breaker shall be provided to supply switchboard buss voltage to the heaters, all prewired by the Manufacturer to fused terminals.

C. Finish shall be electrostatically applied finish paint over iron oxide rust inhibitor primer. Finish color shall be [manufacturer's standard color], [olive green Munsel #7GY3.29/1.5]. The bottom side and bottom 6-inches of the equipment shall be coated with 4-mil minimum thickness rust inhibitor undercoating over finish paint, on all interior surfaces. Finish withstand test without face corrosion or blistering:
1. Salt spray withstands - 2000 hours ASTM B117.

2. Humidity withstands - 750 hour ASTM D2247.

D. Exposed Hardware and Hinges Shall be Stainless Steel Type 302 or 304, Tamper Resistant

PART 3 - EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer's written instructions and applicable portions of NECA's "Standards of Installations" for switchboards, switchgear and motor control centers.

B. Prior to energizing and testing, manufacturer's field engineer shall visually inspect and verify devices are operational and bus connects complete.

3.02 ANCHORING

A. Bolt equipment to floor and wall where wall exists. Where units are free standing, provide preformed steel channel or angle iron bracing to nearest wall or building structural member.

B. Equipment anchoring shall be designed for compliance with the earthquake seismic vertical and lateral acceleration of the equipment install location. Submit structural calculations and details.

3.03 FIELD TESTING INSPECTIONS AND COMMISSIONING (ADDITIONAL REQUIREMENTS)

A. Test all equipment after the installation has been completed, and the District's Representative has been given 10-days notice of the proposed tests. The CONTRACTOR shall provide operating tests demonstrating that all equipment and devices operate in accordance with the requirements of the documents.

B. Adjustable Settings
1. Shall be set and tested after the equipment installation is complete, for proper operation at set points, pickup, and/or drop-out points. Shall be performed by an independent test laboratory and trained certified technicians actively engaged in testing and using test instruments designed and manufactured for the purpose.
2. Provide protection device settings and test, to insure operation and coordination as described in the time/current coordination final submittal, and in accordance with the contract documents.
3. Calibrate and testing shall comply with the equipment manufacturer recommendations.
4. Correct deficiencies, non-compliant equipment and retest to demonstrate compliance.
5. Submit reports to District's Representative, six (6) copies.

3.04 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. Provide a red and white Bakelite nameplate with ½-inch high letters in each section fastened to face of dead-front plate, to read: "DANGER 480 (actual volts) VOLTS, KEEP OUT, AUTHORIZED PERSONNEL ONLY".

B. Manufacturer shall stencil the equipment name on each device and equipment section to correspond to the identification of the drawing.

C. Devices mounted in equipment controlling protective devices shall be provided with nameplates indicating device controlled or monitored.

END OF SECTION

SECTION 26 24 16
BRANCH CIRCUIT PANELBOARDS AND TERMINAL CABINETS

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other specification sections and drawings for related work required to be included as work under Division 26.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Provide manufacturers catalog data for panels, cabinets, and circuit breakers.

B. Provide Shop Drawing showing panel circuit arrangements, size, voltage, ampacity, overcurrent protective devices, etc.

C. Provide nameplate engraving schedule.

D. Short Circuit, Coordination and ARC-FLASH
   1. Perform and submit engineered settings for each equipment location, fuse and adjustable circuit breaker device, showing the correct time and settings to provide the selective coordination within the limits of the specified equipment, per the latest applicable standards of IEEE and ANSI. Provide electrical system short circuit fault analysis, both 3-phase line-to-line and 1-phase line-to-ground calculations as part of the coordination analysis recommendations. Provide Electric ARC-FLASH calculations as part of the coordination analysis recommendations.
   2. The information shall be submitted in both tabular form and on time current log-log graph paper, with an engineering narrative. Written narrative describing data, assumptions, analysis of results and prioritized recommendations, six (6) copies.
   3. The goal is to minimize an unexpected but necessary electrical system outage and personnel exposure to the smallest extent possible within the fault occurrence location, using the specified contract equipment. Shall comply with, but not limited to:
      a. IEEE-242, Recommended Practices for Protection and Coordination of Industrial and Commercial Distribution.
      b. IEEE-399, Recommended Practice for Industrial and Commercial Power System Analysis.
      c. IEEE-1584, Guide to Performing ARC-FLASH Hazard Study.
      d. CEC/NEC
   4. Electrical equipment including switchgear, switchboards, electrical panels, and control panels, transformers, disconnects, etc., shall each be labeled by the manufacturer with “Electrical-ARC-Flash” warning signs. The signs shall explain a hazard to personnel may exist if the equipment is worked on while energized or operated by personnel, to wear the correct protective equipment/clothing (PPE) when working “Live”, or operating “Live” equipment and circuits.

1.03 SEISMIC EARTHQUAKE AND WIND LOADING WITHSTAND, TESTING AND CERTIFICATION. (ADDITIONAL REQUIREMENTS)

A. General
   1. The complete panels and terminal cabinet assemblies; including circuit protection devices, meter, housings/enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested.

a. Wind loading all outdoor equipment locations.
b. Earthquake seismic zone-4 and CBC/IBC Seismic withstand, all indoor and all outdoor equipment locations.

2. Shall withstand, survive and maintain continuos non-interrupted energized operation during the seismic event occurrences and wind event occurrences. Continued normal energized operation after the wind event and seismic event occurrences have abated.
3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation. Acceptance test seismic qualification shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
4. Provide three (3) dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading not less than as follows and as required by AHJ:
   a. 100MPH – West coast states USA and Hawaii.
   b. 150MPH – East coast states USA, Gulf coast states USA and Alaska state.
   c. 90MPH – all other USA locations.
5. Seismic test shall be performed by a third party independent test laboratory. Wind analysis and seismic Testing and reports shall be certified, signed and "stamped" by PE Professional Engineer licensed and in good standing in the State, Civil Engineer or Structural Engineer.

PART 2 - PRODUCTS

2.01 PANELBOARDS AND DISTRIBUTION PANELS

A. Shall be flush or surface mounting as indicated with group -mount circuit protection devices as shown on panel schedule, hinged lockable doors, index cardholders and proper bussing.
   1. Panelboards shall comply with the latest versions:
      a. NEMA – PB1.
      b. UL – 50 and 67.
      c. CEC/NEC.
      d. ASTM-B187.
   2. Where indicated on the drawings shall be furnished with subfeed breakers and/or additional conductor lugs, split bussing, contactors, time switches, relays, etc., as required.
      a. Branch circuit panels up through forty-two (42) circuits shall be single section, to accommodate all of the circuits and components.
      b. Distribution panels shall be single section or multi-section, to accommodate all of the circuits and components.
   3. Panels shall be "Service-Entrance" equipment rated when the panel main incoming supply feeder originates from one of the following:
      a. Originates outdoors exterior of the building in which the respective panel is located.
      b. Originates from an electrical supply source not located in the same building as the respective panel.

B. Housing and Painting, Panels and Terminal Cabinets
   1. Shall be finished with one (1) coat of rust inhibitor zinc chromate and coat of primer sealer after a thorough cleaning.
   2. Finish color paint as selected by DISTRICT 's Representative where exposed to public view (e.g., corridors, covered passages, offices, etc.). Prime coated panelboard shall be painted to match surroundings after installation in public areas.
   3. Manufacturer's standard color in electrical rooms/closets, janitor's, HVAC and storage rooms.
   4. Shall be fabricated of sheet steel of the following minimum gauges.
      a. Full height hinged, locking door. Trim #12 gauge steel; enclosure - code gauge steel.
      b. Panels installed in indoor dedicated electrical equipment rooms and dedicated electrical equipment closets, omit full height hinged locking panel door. Dead front cover behind omitted panel door shall remain.

5. NEMA-1 Metal Housing, for indoor locations.
6. NEMA-3R Metal Housing, tamper resistant, for outdoor locations.
7. Furnish all panels and terminal cabinets with the manufacturers flush locks and keys except where indicated otherwise herein. Keys and locks shall be interchangeable for all panels. Provide two (2) latches and two (2) locks for door heights exceeding 36-inches.
8. Fasten the trim to panel and terminal cabinets by means of concealed, bolted or screwed fasteners accessible only when the door is open.

C. Panels 208/120 volt, three phase, 4-wire, S/N or 120/240 volt, single phase, 3-wire, S/N.
Branch circuit panel as manufactured by:
1. Cutler Hammer "Pow-R-Line 1 or 2" Series
2. General Electric "A" Series
3. Square D "NF/NQ" Series
4. Siemens "P1/P2" Series

D. Branch circuit panels for 480/277 volt, three phase, 4 wire, S/N.
Panelboard as manufactured by:
1. Cutler Hammer..... "Pow-R-Line 2" Series
2. General Electric..... "A" Series
3. Square D ..... "NF" Series
4. Siemens ..... "P1/P2" Series

E. Distribution panels as manufactured by:
1. Cutler Hammer "Power-R-Line 3 or 4" Series
2. General Electric "Spectra" Series
3. Square D "I-Line" Series
4. Siemens "P4/P5" Series

F. Top and bottom gutter space shall not be less than 6-inches high. Provide 6-inches additional gutter space in all panels where double lugs are required, or where cable ampere size exceeds bus ampere size. Provide 12-inches additional gutter space in all panels for aluminum feeders where used.

G. Panel dimensions.
1. Panels with buss sizes 50 ampere thru 400 ampere
   a. Shall be 20-inches wide. Surface or flush mounting as indicated.
   b. Recess mounted type shall have a 20-inches wide (maximum) recess metal enclosure with overlapping edge trim plate cover extending 1-inch on all sides of enclosure.
   c. Depth shall be 5.75-inches nominal. Height of panel as required for devices.
2. Panels with buss sizes greater than 400 ampere
   a. Narrow panels 24-inches (maximum) wide by 6.5-inches (maximum) deep units. Wide panels 25-inches to 44-inches (maximum) wide by 8-inches to 15-inches (maximum) deep units. Nominal 90-inch panel height.
   b. The wider units shall be used only at locations where the narrow unit is not available with the quantity or size of large-ampere frame branch/subfeed circuit protective devices shown on the panel schedules, or where the main breaker size exceeds the narrow panel maximum.
   c. Distribution panels shall be floor standing and also supported from behind the panels at walls.

H. Distribution panels and branch circuit panels maximum load rating
1. Panelboards and Distribution Panels exceeding 800-ampere load rating shall not be permitted.
2. Provide Distribution Switchboards instead of Distribution Panels for bus load and circuit load ratings exceeding 800 ampere.

I. Panel Auxiliary Cabinets
   1. Panelboards shown on the drawings with relays, time clocks or other control devices shall have a separate auxiliary metal barriered compartment mounted above panel.
   2. Panelboards with circuits controlled by low voltage remote control relays shall be provided with separate auxiliary cabinets to contain the relays, adjacent to the panelboard.
   3. Provide auxiliary cabinets with separate hinged locking door to match panelboard.
   4. Provide mounting subbase in cabinet for control devices and wiring terminal strips.

J. Panels shall have a circuit index cardholder removable type, with clear plastic cover. Index card shall have circuit numbers imprinted to match circuit breaker numbers.
   1. The panel identification nameplate shall describe the respective panel name and voltage, corresponding to the contract documents.
   2. The electrical power source, name and location of each panel supply-feeder and supply equipment name shall also be identified and described on the respective panel nameplate.

K. TVSS - Transient Voltage Surge Suppresser
   1. Provide each of the following branch circuit panel and distribution panel types with a TVSS and RF filtering:
      a. 208/120 volt - single phase and/or three phase.
      b. 120/240 volt - single phase.
      c. 480/277 volt - single phase and/or three phase.
      d. All distribution panels.
   2. The TVSS shall be installed inside the respective panel housing and shall be factory connected to each main phase, ground and neutral bus inside the panel.
   3. The TVSS monitor/annunciator indicators shall be visible only when the panel access door is in the open position.
   4. Provide a 20-ampere 3-pole (2-pole for single-phase panels) branch circuit protection device in each panel for TVSS connection.
   5. The TVSS device and panel shall be UL labeled and listed for combined use. See related specification sections for additional TVSS requirements.

L. Seismic Earthquake and wind loading withstand, testing and certification (ADDITIONAL REQUIREMENTS)
   1. The complete panel/panelboard assembly; including circuit protection devices, housings/ enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested for wind loading and earthquake seismic zone-4 withstand.
   2. Shall withstand, survive and maintain continuos non-interrupted energized operation (running) during the seismic event occurrences. Continued normal energized operation after the wind event and seismic event occurrences have abated.
   3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation.
   4. Provide three (3) dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading as follows:
      a. 100MPH – West coast states USA and Hawaii.
      b. 150MPH – East coast states USA, Gulf coast states USA and Alaska state.
      c. 90MPH – all other USA locations.
   5. Acceptance test seismic qualification of proposed panels and panelboards shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
   6. Seismic test shall be performed by a third party independent test laboratory. Wind analysis and seismic Testing and reports shall be certified, signed and “stamped” by PE Professional Engineer licensed and in good standing in the State, Civil Engineer or Structural Engineer.

2.02 Short Circuit Rating

A. Circuit protective devices and bussing as indicated on the drawings. All devices and bussing shall have a short circuit fault withstand and interrupting capacity not less than the maximum available fault current at the panel and as indicated on the drawings, plus a 25% additional capacity (safety margin). However, in no case shall the short circuit fault interrupting and withstand capacity be less than the following symmetrical short circuit.

C/B and/or Bus Rating	Circuit Voltage	Short Circuit Amp.
1. 400A and less	240V and below	10,000A
2. 400A and less	over 240V and below 600V	14,000A
3. Over 400A & 800A & below	240V and below	42,000A
4. Over 400A & 800A & below	over 240V and below 600V	30,000A

B. Panel short circuit fault rating
   1. General
      a. Provide a "fully rated" for short circuit fault interrupt and full load ampere main circuit breaker in each branch circuit panel and/or each distribution panel. Provide the main circuit breaker whether or not a main circuit breaker is shown otherwise on the drawings, schedules or diagrams. The "utility-source" plus the "motor-load" transient contributions shall be used to establish the available fault duty values, unless indicated otherwise on the drawings.
      b. The panel main circuit breaker full load ampere capacity rating shall equal the respective panel main bus ampere rating.
      c. The panel assembly, buss and circuit protection devices bolted fault short circuit withstand and bolted fault short circuit interrupt ratings shall not be less than 125% greater (including a 25% safety margin) than the available utility-source symmetrical and asymmetrical bolted fault short circuit current when "series combined rated" with the panel main circuit breaker.
      d. The main circuit breaker rated "bolted-fault" short circuit fault interrupt and withstand short circuit rating shall not be less than 125% (including a 25% safety margin) of the upstream main service entrance "bolted-fault" available (symmetrical and asymmetrical) short circuit current.
   2. Distribution Panelboards
      a. Distribution panel, main circuit breaker, all feeder circuit breakers, and all branch circuit breakers shall be "fully-rated" (plus safety margin) for the available bolted fault short circuit current (including safety margin).
      b. Shall provide time/current-tripping coordination with downstream equipment and upstream equipment.
   3. Non-emergency branch circuit panelboards 400-ampere buss and smaller; Non-emergency branch circuit panelboards 400-ampere trip main circuit breaker and smaller.
      a. The branch circuit panel main circuit breaker shall be "fully-rated" (plus safety margin) Current Limiting Circuit Breaker type (CLCB). Shall provide time/current- tripping coordination with upstream equipment.
      b. The branch circuit panel main circuit breaker shall be "series-rated" with the panel downstream branch circuit devices and panel bussing. "The series-rating" shall provide short circuit bolted fault current withstand protection and short circuit bolted fault interrupt rating protection during a downstream 3-phase line-to-line and/or single-phase line-to-ground short circuit bolted faults.
      c. Typical for branch circuit panelboards connected to normal-power (non-emergency) power circuits.
   4. Emergency branch circuit panelboards 400-ampere bus and smaller; Emergency branch circuit panelboards 400-ampere trip main circuit breaker and smaller.
      a. The branch circuit panel main circuit breaker shall be short circuit bolted fault "fully-rated" (plus safety margin) non-Current Limiting circuit breaker type (non-CLCB).
      b. The panel bussing shall also be short circuit bolted fault "fully-rated".

c. All of the branch circuit panel, branch circuit breakers shall be “fully-rated” non-fused Current Limiting Circuit Breaker Type (CLCB). Shall provide short circuit bolted fault interrupt rating. Coordinated time/current and instantaneous tripping with the upstream circuit protection devices.
d. Typical for branch circuit panelboards connected to emergency power circuits.

2.03 PANEL CIRCUIT BREAKERS, CIRCUIT PROTECTION DEVICES

A. Circuit Breakers General, for Distribution Panels and Panelboards
1. NEMA-AB1 and AB3, comply with latest revision.
2. UL-1087, UL-489 and IEC-60.947.2 rated devices, comply with latest revision.
3. 5Hz AC closing and 3Hz AC trip and clear.
4. Main circuit breakers for distribution panels exceeding 400 ampere and larger;
   a. Shall be Insulated Case Circuit Breaker type ICCB.
5. Main circuit breakers for branch circuit panelboards 400 ampere buss and smaller;
   a. Shall be Current Limiting Circuit Breaker type-CLCB for non-emergency panelboards.
   b. Shall be Molded Case Circuit Breaker type-MCCB for emergency panelboards.
6. Branch circuit breakers and feeder circuit breakers smaller than 100-ampere trip shall be Molded Case Circuit Breakers type-MCCB and/or Current Limiting Circuit Breakers type-CLCB.
7. All circuit breakers 100 ampere and larger trip shall employ sensors and solid state digital electronic automatic trip system. Short-time and long-time Time/current curve shaping field adjustable functions and adjustable instantaneous trip. Typical for Molded Case Circuit Breaker type-MCCB, Insulated Case Circuit Breaker type-ICCB and Current Limiting Circuit Breaker type-CLCB.
8. Refer to Specification Section 16425 and/or 16312 for additional circuit breaker requirements.

B. Manufacturer
1. Circuit breakers as manufactured by the following companies only are acceptable:
   a. Cutler Hammer
   b. General Electric Co.
   c. Square D Co.
   d. Siemens

C. Configuration
1. Circuit breakers shall be arranged in the panels so that the breakers of the proper trip settings and numbers correspond to the numbering in the panel schedules on the drawings.
2. Circuit numbers of breakers shall be black-on-white micarta tabs or other previously approved method. Circuit number tabs, which can readily be changed from front of panel, will not be accepted. Circuit number tabs shall not be attached to or be a part of the breaker.
3. Panelboard circuit protection devices shall be bolt on type for connection to panel bus. Removable and installable without disturbing adjacent devices.
4. Provide conductor wire terminations (lugs) on each circuit protection device for incoming main feeder, branch circuits and outgoing feeder circuits. Dual rated copper/aluminum and compatible with the respective conductor size, type, and quantity.
5. Where 2-pole or 3-pole breakers occur in the panels, they shall be common trip units. Single pole breakers with tie-bar between handles will not be accepted.
6. Branch circuit panels shall be field convertible for bottom entry main incoming feeder or top entry main incoming feeder.
7. Each panel section, the feeder and branch circuit protection devices (3-phase and/or 1-phase) shall be “twin-mount”, side-by-side double row construction for the following circuit sizes:
   a. 480/277 volt, 60-ampere circuit size and smaller.
   b. 240 volt – 208/120 volt, 100 ampere circuit size and smaller.

D. Lock-Off and Lock-On
   1. All circuit breakers shall be pad-lockable in the "off" position.
   2. Where branch circuit breakers supply the power to motors and signal systems, the breakers shall also be furnished with lockout clips, mounted in the “on” position. The breakers shall be able to trip automatically with lockout clips in place.
   3. Provide lock-on clips on branch circuit breakers supplying fire alarm equipment and fire alarm panels. Provide identification of the dedicated "fire alarm" circuit function and operation. Color-code the circuit breakers to comply with AHJ requirements.
   4. Locking facilities shall be riveted or mechanically attached to the circuit breaker (submit sample for approval. Other means of attachment shall not be accepted without prior written approval of the District's Representative.

E. ARC Fault Interrupter Circuit Breaker (AFCI-C/B)
   1. AFCI-C/B provides automatic circuit interruption upon detection of any of these conditions: overload, short circuit fault and electric branch circuit arcing protection.
   2. The AFCI-C/B shall detect intermittent “arcing” type electrical faults, and provide automatic circuit interruption (tripping).
   3. Provide “test-pushbutton” on each C/B for manual AFCI-C/B testing.
   4. Single pole, 120-volt, 60Hz AC UL listed and labeled for installation in panelboard, #14 - #8AWG solid/ stranded AL/CU load conductor.

F. Switch and Fuse Feeder Protective Devices for Distribution Panels
   1. Locations where the drawings show distribution panels employing switch-fuse circuit protection devices.
   2. Fusible Switches: Quick-make, quick-break type with rejection clips for use with Class “R” fuses current limiting fuses (CLF). Switches with ratings up to and including 100 ampere at 240 volts shall be twins mounted. Switches rated through 60 ampere and 480 volts shall be twins mounted. Provisions for padlocking in the “on” and/or “off” positions. Switches shall be removable from front of panel without disturbing adjacent units or panel bus structure.
   3. Fuses shall be time delay current limiting types, UL Class RK-1 unless otherwise indicated on the drawings. Provide one (1) spare set of fuses of each size and type in each Distribution Panel.
   4. Provide auxiliary contact on switch for remote status (on-off) signaling and monitoring. Provide conductor lugs to accept conductor temperature rating, sizes and quantities shown on drawings.
   5. Switch and fuse devices shall be permitted only in distribution panels and only where specifically indicated on the drawings for feeders.

2.04 PANEL BUSSING

A. Bus Material
   1. Bussing shall be rectangular cross section tin-plated copper or alternately silver or tin-plated aluminum.
   2. Bussing shall be non-tapped, full length of the enclosure.

B. Ground Bus
   1. Each panel shall be equipped with a ground bus secured to the interior of the enclosure. The bus shall have a separate lug for each ground conductor. No more than one conductor shall be installed per lug.

C. Provisions
   1. Provide space and all hardware and bus mounting attachments for future devices as indicated on the drawings.

D. Neutral Bus
   1. The ampere rating of the neutral bus of panels and distribution panels shall be a minimum of 100% greater ampere capacity than the ampere rating of the corresponding phase bus, where the panel is indicated to be provided with an “oversize-neutral” or “200%” neutral on the drawings.

2.05 TERMINAL and AUXILIARY CABINETS

A. Cabinets
   1. Fabricated of code gauge sheet steel for flush mounting (except where noted as surface) of size indicated on the drawings, and complete with hinged lockable doors, provide the quantity of 2-way Feed through conductor terminals required for termination of all conductors, plus 15% spares of each type.
   2. Cabinet locks to operate from same key used for panelboards. The trim to cabinets shall be fastened by means of concealed bolted or screwed fasteners accessible behind door into cabinets. All cabinets shall have ⅝-inch plywood backing, finished with fireproof intumescent primer and finish coat paint. Provide equipment ground bus in each cabinet.
   3. Cabinets shall be finished with one coat of zinc chromate and one coat of primer sealer after a thorough cleaning. Where exposed to public view (e.g., corridors, covered passages, offices, etc.) finish color paint to match surrounding and manufacture’s standard gray color in switchboard, janitors, heater and storage rooms.
   4. Provide grounded metal barriers inside cabinet to isolate and separate line voltage and low voltage from each other inside the cabinet.

B. Cabinet dimensions.
   1. Unless indicated otherwise on drawings.
      a. Shall be 20-inches wide. Surface or flush mounting as indicated.
      b. Recess mounted type shall have a 20-inches wide (maximum) recess metal enclosure with overlapping edge trim plate cover extending 1-inch on all sides of enclosure.
   2. Depth shall be 5.75-inches nominal. Height of cabinet as required for devices, plus 25% spare unused interior space for future use, but not less than 36-inches high.

C. Terminals
   1. Non-digital analog circuits; line and low voltage modular signal systems, 15-ampere dual row with isolation barriers, screw-down terminals insulated strips, heavy duty.
      a. As manufactured by Molex, or ITT-Cannon, or General Electric.
   2. Digital circuits; low voltage signal systems, ANSI/ EIA/TIA Category-6, 110-Block or 66-Block gas-tight punch down style, heavy duty.
      a. As manufactured by: Leviton, or Ortronics, or AMP.

D. Identification (additional requirements)
   1. Provide engraved nameplate on each cabinet indicating its designation and system (i.e., “Life Safety System - Panel 2LS”, etc.).
   2. Identify each terminal landing with unique circuit number and provide corresponding alphanumeric text-index card inside panel access door

PART 3 - EXECUTION

3.01 MOUNTING

A. Flush mounted panelboards and terminal cabinets shall be securely fastened to at least two studs or structural members. Trim shall be flush with finished surface.
   1. Panels and cabinets installed flush (recess or semi-recess) into fire rated or smoke rated walls. The wall recess shall be fully wrapped inside the recess with fire/smoke rated materials. The wrap-materials shall provide the same fire and/or smoke protection rating as the respective wall.

B. Surface mounted panels and terminal cabinets shall be secured to walls by means of preformed galvanized steel channels securely fastened to at least two (2) studs or structural members.

C. Panelboards and terminal cabinets shall be installed to insure the top circuit protective device (including top compartment control devices) are not more than 6-feet-6-inches above finish floor in front of the panel and the bottom device is a minimum of 12-inches above the floor. Manufacturer shall specifically indicate on shop drawing submittals each panel where these conditions can not be met.

3.02 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. Provide a red and white Bakelite nameplate with ½-inch high letters in each 277/480 volt panel fastened to face of dead-front plate, to read: "DANGER 480 (or as applicable) VOLTS KEEP OUT AUTHORIZED PERSONNEL ONLY".

B. Manufacturer shall stencil the panel/cabinet number identification on the inside of door to correspond with the designation on the drawings.

C. Identification plates and numbers shall be attached with screws or twist lock fasteners. Adhesive attachment of any kind shall not be used.

3.03 SPARE CONDUITS (ADDITIONAL REQUIREMENTS)

Provide three (3) 1-inch conduit only stubs from each panel and terminal cabinet into accessible ceiling space. Where floor level below panel or terminal cabinet is accessible, also provide an additional three (3) 2-inch conduit only stubs into accessible floor space.

END OF SECTION

SECTION 27 13 33

TELEVISION DISTRIBUTION SYSTEM

PART1 GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment, facilities transportation and services necessary for an incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other sections for work related to those other sections and required to be included as work under this section.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit copy of document certifying that the installer of the system is authorized by the manufacturer of the cable and equipment to design and install the system.

B. Submit a document stating that the installer of the system maintains a fully-equipped and staffed service facility complete with all spare parts necessary to maintain and/or repair the system and to properly use all test equipment.

C. Submit copy of installer's valid C-7 Contractor's license.

D. Submit a list of at least ten (10) projects of similar scope completed by the installer.

E. Submit product data sheets and descriptive literature for all component parts and cabling.

F. Submit a block diagram of the entire system showing the calculated signal levels at the output of every active component and at every outlet in the system. The levels shall be noted in DMBV @54 MHz and at 470 MHz. The levels shall be noted for the return path on subchannels 13 MHz and 43 MHz to the headend from the worst case outlet in the system. Submit loss calculation for the worst case outlet in the system.

G. At the completion of the project, the Contractor shall provide complete as-built drawings and service manuals. The drawings and manuals shall include the following:
   1. Identification of all components and cable runs in the system. The identification numbers must match those used in construction.
   2. Signal level measurements as hereinbefore specified.
   3. Signal-to-noise and feeder-line resistance as specified.
   4. Service manuals and schematic diagrams of all active components used in the system.
   5. A complete block diagram with all specified measurements and outlet I.D. numbers. Diagram shall be on 8 1/2" x 11". Also furnish one (1) diskette copy in AutoCAD, Designer, Corel, or Excel format.
   6. The complete manuals must be assembled and organized to permit easy reference and cross-checking and to facilitate future servicing.
   7. All information shall be printed or typewritten.

1.03 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. Label each end of each new building entrance cable to indicate the building number as identified on the site electrical drawings, e.g., "P19".

1.04 EQUIPMENT QUALIFICATIONS

A. Each item referred to on the drawings and in these specifications represent the standard of quality required by the District. Where the manufacturer's name and model number are used, it is understood that the manufacturer's published specification sheets are wholly embodied herein. The Contractor shall submit a bid covering each item and method as specifically described herein.

B. System shall comply with TIA 568/569. Grounding shall be per NEC Article 820 Part C and BICSI TOM Section 18.

C. System shall meet or exceed the technical standards set forth in FCC rules Part 76.

PART 2 PRODUCTS

2.01 The system shall include all materials and equipment and labor required to distribute all channels from the local cable TV Utility Co. service and local Campus feed areas.

2.02 The system shall meet the following performance specifications on each operational channel with all channels carrying signals within the specified operating levels.

A. Minimum amplifier gain: 45.5db.

B. Maximum outlet level: plus 12DBMV at outlet tapoffs.

C. Minimum outlet level: plus 6DBMV at outlet tapoffs.

D. Signal-to-noise ratio: 42db or greater.

E. Cross modulation level at the output of the distribution amplifier: greater than 46db.

F. Minimum isolation between any two outlets: 28db for frequencies between 10 MHz and 300 MHz; 20db over a total range of 5 MHz to 750 Mhz.

G. Channel balance: maximum 3dB difference between adjacent channels.

H. The picture quality at each outlet as viewed on one of the schools existing receivers shall show no visible degradation of picture quality over that observed with the same receiver connected directly to the incoming cable TV feed.

I. The Contractor shall provide pads, equalizers, and/or tilt compensators as required to balance the input and output of the distribution amplifier to provide a balanced output on every operative channel.

J. All passive distribution equipment installed after the first distribution amplifier shall be designed to operate at all frequencies from 5 MHz to 890 MHz.

K. System shall allow insertion of two separate simultaneous transmissions from any of the system outlets on subchannels T8 and T9 to the headend. Subchannel shall operate simultaneously with all forward channels.

L. Headend equipment shall convert the incoming subchannels to Channels 33 and 42, respectively, for forward redistribution into the system.

M. Provide traps to filter out incoming cable TV channels 33 and 42.

N. Amplifier bandwidths shall be from 50 MHz to 550 MHz in the forward direction and from 5 MHz to 30 MHz in the reverse path.

2.03 The following list of major equipment items are listed to establish quality and shall not be construed as a complete list of items required for the system:

A. Distribution amplifiers: Blonder-Tongue, "BIDA 5400-55" series with "RA" return amplifier or equal and the appropriate filters.

B. Wall Taps: Radiation-proof with coupling value and connection configuration as required for system performance at each location as indicated.

C. Splitters: Blonder-Tongue "XRS" series or equal.

D. Directional Couplers: Blonder-Tongue #CRS series.

E. Modulator: Blonder-Tongue, Stock No. 5992 series or equal.

F. Channel Elimination filters: Microwave Filter Company, Part #3367-216, #6211LP-568/589.25, #3322-568/600(50), #3271SUBPT8.

G. Channel Converter: Blonder-Tongue, Stock No. 1459 series or equal.

H. High-Output Saw Filtered AudioVideo Processor: Blonder-Tongue "ESHP" series or equal.

I. Headend Combiner: Blonder-Tongue, Stock No. 5956 or equal.

J. Equipment Rack: Soundolier #UWA200-61 with plug strip inside for 120 volt connections.

2.04 CABLE

A. Main trunk cable running between the headend equipment and each terminal cabinet shall be Commscope P3-75-500JCASS series nominal .500"0.D. with aluminum sheath.

B. Cables from terminal cabinets to directional couplers shall be PVC-jacketed, coaxial copper-clad center conductor, foam dielectric, tape, and aluminum braid shield. Size and attenuation rating of cable shall be as required to achieve overall system performance as indicated.

C. All coaxial cable terminations and connectors shall be designed for the cables provided and installed per manufacturer's specifications. No soldered or handmade connections will be permitted.

2.05 All equipment shall be designed and rated for 115 volts 60 Hz AC operation and shall be UL rated for 24 hours a day continuous operation.

PART 3 EXECUTION

3.01 No coaxial cables which show bruises, kinks, or shipping damage shall be installed in this system.

3.02 No coaxial connectors, fitting, terminations, or junctions shall be installed in any inaccessible location. Said connections shall only be made at outlets or terminal cabinets.

3.03 Extreme caution shall be exercised in the installation of all cables to avoid abrasions, accidental grounds or cable distortions.

3.04 TESTING

A. Before the contract shall be considered complete, the Contractor shall demonstrate the performance of the system in the presence of the District. The Contractor shall provide all test and reception gear required to prove the performance as outlined.

B. The District may order any changes, adjustments or further tests deemed necessary to assure that the system is complete and operating in accordance with these specifications. All costs of tests and documentation will be borne by the Contractor.

C. Measure and record signal levels in DBMV on channel and channel at every new outlet in the system and at the headend.

D. Measure and record signal-to-noise ratio at every outlet of the system.

E. All signal measurements shall be observed and recorded using recently calibrated test equipment equal to Wavetek SAM II or Sencore SL750.

END OF SECTION

SECTION 27 20 00

ELECTRONIC NETWORK SYSTEMS INFRASTRUCTURE
(Computer/Data, Telephone/Voice, Audio/Video, TV and Multimedia)

PART 1 - GENERAL

1.1 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:

1. Examine all other specifications sections and drawings for related work required to be included as work under Division 26.

2. General provisions and requirements for electrical work.

B. Provide electronic network systems infrastructure for the following systems:

1. Computer Data Networks

2. Telephone and Intercom Voice Communications

3. Audio Visual Instruction and Communication Systems

4. Other special systems described in the contract documents.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Drawings Submittals

1. Drawings shall be submitted on reproducible sepias and Autocad® Version 2.2 (or later revision) data files on CD/DVD-ROM disk, WINDOWS® Version-7 or greater format.

2. Submit redrawn building floor plan and wall elevation for each building area, same scale as the contract drawing.

3. Plans shall show walls, doors, windows, furniture, infrastructure, outlets and network systems equipment locations. Show point-to-point interconnecting cables, pathways, conduit, conduit sizes, and circuit types, along with circuit identification names, numbers, and quantities between all components.

4. Provide scaled elevation drawings of each equipment rack, terminal blocks, terminal backboard and terminal room/closet showing location and arrangement of each equipment component, outlet and cable training provisions, with estimated weight of each complete assembly.

5. Submit block wiring diagrams showing major system components, outlets, equipment racks, terminal blocks, signal loss with interconnecting circuit conductors, splices, portable patch cords and connectors. Riser type diagram shall be provided if the building has more than one floor level, with information shown on riser diagram corresponding for each respective floor.

B. Submit manufacturer's standard catalog data for each component. The submittal shall be arranged in the order of the Specification and shall list the specification paragraph number, the name, the proposed model and manufacturer for each item as well as a reference indicating the specific piece of data which can be easily located in the brochure. The manufacturer's data sheets shall be marked to indicate the specific item being proposed in cases where the sheet covers several types or sizes of items. The data sheet shall completely describe the proposed item. Where modification to the equipment is necessary to meet the operational requirements of the contract documents, the brochure shall include complete mechanical and electrical shop drawings, detailing the modification. The brochure shall include a listing of the outlet rough-in requirements for every device and equipment item. The applicable symbol which illustrates that rough-in item on the job plans shall be drawn on the proposal, opposite the description of the rough-in to facilitate locating the data by field personnel. Equipment needing line voltage power must be coordinated with Electrical Contractor and highlighted and noted to the engineer for inclusion with the Power Plans. Submit elevation and dimensional information.

C. Performance Calculation:

1. Provide engineered calculations showing the Passive Cable System Signal Attenuation losses of the proposed installed system. The intent is not to require calculations for every system segment, port and outlet. The intent is to require engineered calculations for proposed typical worst case port to port, head end to farthest distance outlet and patch port to outlet signal attenuations.

2. Provide calculations for a minimum of twenty-five (25) complete channel/circuit paths. The calculations shall include attenuation insertion losses for each system component including individually itemized cable-fiber/wire; outlet, termination, connector, electronic component (if any), coupler and patch cord along the entire path from the head end equipment to the end use outlet.

3. The calculations shall serve as the basis for verifying the system performance with the system testing specified in the Contract Documents.

D. Provide proposed nameplate and outlet identification/color coding system. Indicate proposed identification naming sequence and methods, itemized for review.

E. Submit manufacturer certified test reports showing test documentation for the proposed material that the material meets or exceeds the performance standards defined in the contract documents. The testing and results shall reflect worst case performance based on a minimum of ten samples. Tests shall be certified by a Nationally recognized independent test lab (i.e., ETL, UL, etc.). The manufacturer shall certify in writing the material has been manufactured and tested to comply with the requirements defined in the contract documents.

F. Submit three (3) samples of each of the following, fully assembled with 24-inches of cable type connected:

1. Copper wire outlet and connector, with each type of specified inserts.

2. Copper cables and patch cords, each type.

3. Fiber optic cables and patch cord each type.

4. Mechanical splice - fiber optic.

5. Fusion splice - fiber optic.

6. Fiber optic outlet and connector each type.

7. Fiber optic cable connector each type of termination, with interconnection coupler.

8. Patch panel each type.

9. Coverplate each type.

1.3 APPLICABLE STANDARDS

A. The equipment shall be UL listed, labeled, and approved for the application shown in the contract documents.

B. The complete system material, equipment, testing, installation and workmanship shall comply with the mandatory requirements and the guideline/recommendation requirements of the following latest published version, supplements, latest revision including addendums and TSB. Both the mandatory and advisory criteria shall be included as requirements of the Contract Documents:

1. TIA-526 Optical Power and loss measurements – multimode and single mode fiber.

2. ANSI/TIA/EIA-568C Commercial Building Telecommunications Standards.

3. ANSI/TIA/EIA-569B Commercial Building Standards for Telecommunications Pathways.

4. ANSI/TIA/EIA-570A Residential Telecommunications Standard.

5. ANSI/TIA/EIA-598B Optical Fiber Cabling Color-coding.

6. ANSI/TIA/EIA-606A Administrative Standard for Commercial Telecommunications Infrastructure.

7. ANSI/TIA/EJA-607 Commercial Buildings Grounding and Bonding Requirements for Telecommunications.

8. FCC – FYU/FT6.

9. ISO/IEC-11801

10. National Electrical Code (NEC) and California Electrical Code (CEC) including Articles 770 and 800 with ETL verified testing and local code jurisdictions.

11. NECA/NEIS, National Electrical Contractors Association, National Electrical Installation Standards:

    a. 301 – Standard for Installation and Testing for Fiber Optic.

    b. 568 – Standard for Installing Building Telecommunications Bonding and Grounding.

    c. 607 – Telecommunications

12. Manufacturer's recommendations for the respective equipment.

C. The entire completed Electronic Network Systems Infrastructure shall be tested and provide electronic data/network and telephone/voice multi-channel communications latest revisions, standards and addendums, for the following protocols:

1. IEEE 802.3/ETHERNET:

   a. 10Mbps 10Base-T, 100Mbps 100Base-Tx, and 1000Mbps (1Gbps) 1000Base-Tx for copper wire; 100-meter communications pathway distance.

   b. 10Mbps 10Base-F1, 100Mbps 100Base-FX, 1000Mbps 1000Base-Lx-Sx and 10,000-Mbps (10Gbps) for fiber optics; 550-meter communications pathway distance, OM4 standard for multimode and OS2 for single mode.

   c. IEEE-802.3 for Power Over Ethernet-Plus (POE Plus).

2. FDDI - Distributed data interface on fiber or copper wire, 100Mbps.

3. 100VG - AnyLAN

4. EIA Serial and Bi-directional RS-232 and RS-485m including Star-Hub repeaters

5. ANSI - TPPMD 55Mbps, 155Mbps and 622Mbps Asynchronous Transfer Mode - ATM.

D. The complete telephone/voice infrastructure system shall be suitable for the telephone/voice analog and digital communications and VOIP protocols. The system shall be compatible with the telephone/voice equipment installed as part of the contract.

E. Installation of all infrastructure equipment, devices, splices, terminations, cables, outlets, etc. shall comply with manufacturer's recommendations.

1.4 EQUIPMENT QUALIFICATIONS

A. Equipment

1. The supplier of the equipment shall be the factory authorized distributor and service facility for the brands of equipment and material provided.

2. Network systems infrastructure equipment and materials shall all be the product of one of the individual same manufacturers as follows. Typical unless specifically described otherwise:

   AMP/Tyco – NetConnect series; or Siemons – ConvergeIT series; or Belden – 10GX series.

B. Installation Certification

1. Work and material for cables, cable terminations, outlets and related components for infrastructure systems shall be performed by certified installers. The installer shall be certified by the respective product manufacturers.

2. The manufacturers of the indicated work and material, shall provide an installer education/ training and certification program for the supplied products.

3. The installers performing the Contract work for the indicated products, shall have attended and successfully completed each of the respective manufacturer's installation training education programs for the specified products.

4. Submit six (6) copies of the manufacturer's certifications for each installer performing the work. The submittal shall be approved by the OWNER'S REPRESENTATIVE prior to initiating any related contract work.

5. Contract material installed and work performed by installers not complying with these requirements shall be removed. Removal of work and material not in compliance with these requirements shall done at the CONTRACTOR'S expense, without any additional cost to the contract and without any additional contract completion due date extensions. New material and work required to replace the non-complying removed work and material shall be provided at the CONTRACTOR'S expense, without any additional cost to the contract and without any additional contract completion due date extensions.

C. Extended Material and Performance Warranties

1. In addition to the warranty requirements described elsewhere in the contract documents, provide the following extended material and performance warranties. The warranty period shall be for not less than 15-years from the Contract Notice of Completion.

2. Warranty scope includes all equipment, materials and performance for network cables and terminations, network workstation plug-in outlets, and patch panel plug-in outlets, cable splices and connectors.

3. Repair or replace the defective material with new material at the project premise, to comply with the performance standards outlined in the contract documents during the warranty period.

4. Submit seven (7) copies of proposed warranty statements, with shop drawing submittals.

1.5 ABBREVIATIONS

Abbreviation	Terminology
ACR	Attenuation to Cross Talk
AHJ	Authority Having Jurisdiction
Backbone	Interconnections between MDF and IDF locations
dB	Decibel
dBm	Decibel referenced to a milliwatt
Demarc	Demarcation location where operational control change or ownership change occurs
ft.	Feet
GHz	Gigahertz
Horizontal Connection, and/or Horizontal wiring	Circuit Interconnections between individual workstation outlet location to respective IDF or MDF equipment rack patch panel.
IDF	Intermediate distribution frame (horizontal or vertical cross connect) for an individual building area/floor
KM	Kilometer-lKM
kpsi	1000 pounds per square inch
m	Meter = 39.37 inches
Mbps	Megabits per second
MDF	Main distribution frame (central/main cross connect) for multi-building site or for a single individual building
MHz	Megahertz
micron	Micrometer
mm	Millimeter = $l0^{-3}$ meter
NEXT	Near end cross talk
nm	Nanometer = 10^{-9} meter

pF	Picofarad = 10^{-12} farad
RTDE	Equipment rack mount fiber optic termination distribution enclosure, with fiber optic patch panel
RMSE	Equipment rack mount fiber optic enclosure, splice only, (without patch panel)
STP	Shielded twisted pairs copper wire
ScTP	Shield Screened twisted pairs copper wire
Trunking-Cable	Individually insulated twisted pair copper wire cable, consisting of 24-pair or more of conductors inside a common cable jacket. Terminate and connect to common terminal-block location at each end of the trunking-cable.
um	Micrometer = 10^{-6} meter
USE	Universal splice enclosure
UTP	Unshielded twisted pairs copper wire
VOIP	Voice communications over internet protocol
WGNA	Wide Band Gigabit Networking Alliance
Workstation or Workstation location	Spaces remote from the MDF/IDF terminal room/closet, where occupant interacts with the electronic systems infrastructure equipment connection device
WMIC	Wall mount fiber optic cable interface cabinet

1.6 MATERIALS AND METHODS

A. Material and labor not complying with the contract documents shall be removed by the CONTRACTOR from the project site. Material and labor complying with the contract documents shall be provided.

B. All the cost to remove deficient work and material, provide work and material complying with the contract documents and the direct, indirect, incidental damages and contract delays resulting from complying with these requirements shall be the sole responsibility of the CONTRACTOR and shall be included in the bid price.

C. System Performance Requirements

1. The work, performance and type of materials provided as part of the contract shall comply with the following ANSI/TIA/EIA-568C and related standards for all Electronics Network Systems Infrastructure work and materials described in the specifications and shown the drawings:

   a. Computer/data network systems: Category-6.

   b. Telephone/intercom voice systems: Category-6.

2. The Electronic Network Systems Infrastructure system shall be based on “star-topology” for MDF to IDF backbone connections and workstation outlet to MDF/IDF horizontal connections.

PART 2 - PRODUCTS

2.1 FIBER OPTICS CABLES

A. General

1. Operating temperature range minus 20-degrees centigrade through plus 60 degrees centigrade. Cables shall be flame retarding.

2. All electronic network systems infrastructure cables that are not installed inside conduit raceways and electronic network systems infrastructure cables that are installed in concealed spaces including plenums and non-plenums; access floors, ceiling spaces, walls, floor, etc., and/or installed without continuous raceways:

   The cable insulation and jacket shall be listed and labeled "limited combustible cable" (LC or LCC) and shall comply with the latest published revision of all of the following additional requirements.

   a. Limited combustible "FHC-25/50" per UL-2424.

   b. NEC/CEC;CMP, additional listing/labeling where the install location is an environmental air plenum, "FHC-25/50-CMP".

   c. NFPA-90A; ceiling cavity plenums, wall cavity spaces and raised floor cavity plenums, limited-combustible.

   d. NFPA-5000; defines combustible material including wire and cable.

   e. NFPA-75 computer rooms and electronic equipment room.

   f. NFPA-13; spaces containing "limited combustible loading".

   g. Shall qualify as 100% recyclable materials disposal.

3. All fibers in a multi-fiber cable shall be fully operational within the performance characteristics specified prior to and after the cable is installed. The use of spare fibers in the cable to compensate for defective fibers is not permitted. Defective cables shall be removed and replaced with fully functional cables at no additional cost to the contract.

4. Cables shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with specified requirements. ANSI/TIA/EIA-568C including related standards, amendments and TSB.

5. Each fiber shall be individually identified with factory color coding or factory imprinted label. The outer cable jacket shall be imprinted with date, manufacturer's model and catalog number, along with agency listing identification.

6. Fiber optic cable shall be a product of the same manufacturer, including portable patch cables.

7. The outer cable jacket shall be imprinted with date, manufacturer's model and catalog number and AHJ listing identification.

8. Cables installed in raceways or conduits below grade, through in-grade manholes or pull boxes shall be rated for installation in water/wet locations.

9. Cables containing less than six (6) fiber strands shall be provided with a color-coded outer jacket (red or orange).

10. Multimode (50/125)

    a. 50/125-fiber optic cables optical fibers, graded index multimode optical glass fibers, 50.0-micron fiber core and 125-micron fiber cladding, 0.2 numerical aperture. Optical fibers shall be 100kpsi proof tested, with maximum 0.7-micron flaw size for dual operation at 850nm and 1300nm wavelengths.

b. Minimum bandwidth:

@ 850nm-wave length	500Mhz per KM length
@ 1300nm-wave length	500Mhz per KM length

c. Maximum attenuation:

@ 850nm-wave length	3.4dB @ 1 KM length
@ 1300nm-wave length	1.4dB @ 1 KM length

11. Single mode:

a. Fiber optic cables optical fibers, (8.3/125) single mode optical glass fibers, 8.3 micron core fiber and 125-micron fiber cladding, 0.11 numerical aperture. Optical fibers shall be 100kpsi proof tested, with maximum 0.7 micron flaw size. For operation at 1310nm and 1550nm wave lengths.

b. Maximum attenuation:

@ 1310nm- wave length	0.5dB @ 1 KM length
@ 1550nm - wave length	0.4dB @ 1 KM length

c. Maximum dispersion

@ 1310nm - wave length	2.8ps/nm KM length
@ 1550nm - wave length	18.0ps/nm KM length

B. Loose Tube Gel-filled Cables

1. Multiple, loose tube buffer tubes, gel-filled. Each buffer tube shall contain the same quantity of optical fibers, but not more than twelve (12) optical fibers in each buffer tube.

2. Buffer tubes shall be cabled around a central dielectric strength member. The central strength member shall be centered along the length of the cable.

3. Aramid yarn, non-optical, strength fibers shall extend continuously along the length of the cable.

4. The cable interstitial spaces shall be flooded to inhibit water migration, with non-flammable water blocking gel.

5. Each optical fiber shall be individually UV cured acrylate coated, 250-micron diameter coating over fiber cladding.

6. A seamless black polyethylene outer layer jacket shall envelope the entire cable.

7. The cable shall be fungus resistant, UV resistant, and moisture resistant for installation indoors with or without an enclosed raceway and outdoors in underground enclosed raceway/ conduit and manholes/pull boxes continuously flooded with water.

C. Indoor/Outdoor Cables

1. The cable shall be fungus resistant, UV resistant, and moisture resistant for installation indoors with or without an enclosed raceway and outdoors in underground enclosed raceway/ conduit and manholes/pull boxes continuously flooded with water, and in conduits exposed to the sun.

2. Each optical fiber shall be primary coated with 500-micron uniform acrylate tight buffered and with elastomeric uniform 900 micron diameter tight buffered, secondary coating. Aramid yarn

strength member elements shall be tensioned and symmetrically and uniformly distributed around the fibers, along the length of the cable.

3. An overall cable jacket uniformly extruded directly around and mechanically interlocked with the optical fibers/strength members. The extruded jacket shall form internal helical cusped ridges that interlock with the optical fibers and strength members. The interlocking jacket shall not allow cable fibers to move axially within the cable jacket.

4. Cables containing more than twenty-four (24) optical fibers shall be constructed with sub-cable fiber bundles. Each sub-cable bundle shall contain equal quantities of optical fibers, with a separate PVC jacket around each sub-cable. Sub-cable and sub-cable jacket construction shall match the overall cable requirements and jacket requirements.

5. The cable shall be UL listed and comply with NEC and CEC and NFPA requirements for each installation location shown in the Contract Documents. ETL tested and certified to comply with or exceed specified requirements.

   a. NEC/CEC - OFNR (Vertical Riser Type Locations) OFNP (UL FHC-25/50 LC Plenum Type Locations and locations where not continuously enclosed inside conduits for entire cable length).

   b. NEC/CEC - OFNG (Where continuously enclosed inside conduits for entire cable length).

D. Tight Buffered Cables

1. Each optical fiber shall be coated, 900-micron diameter uniform coating, with uniform tight buffering over the coating, uniform dielectric strength member surrounding the buffering coating and an overall jacket around each optical fiber assembly.

2. Individual multiple optical fiber assemblies shall be symmetrically arranged around a central dielectric strength member. The central strength member shall be centered along the length of the cable.

3. A dielectric strength member shall surround the fiber assemblies.

4. An outer dielectric jacket shall envelope the entire cable.

5. The cable shall be UL listed and comply with NEC and CEC and NFPA requirements for each installation location shown in the Contract Documents. ETL tested and certified to comply with or exceed specified requirements.

   a. NEC [CEC] - OFNP (UL FHC-25/50 LC Plenum type locations and locations where not continuously enclosed inside conduits for entire cable length).

2.2 COPPER WIRE CABLES (TWISTED PAIRS)

A. General

1. Conductors shall be copper wire, individually insulated and color-coded, with multiple conductors arrange in twisted pairs.

2. An overall non-conductive jacket shall encase the copper wires and any shielding (where shielding is specified) shall also be encased by the jacket.

3. Cables shall be UL listed, complying with NEC National Electrical Code, National Fire Protection Agency and NFPA requirements for each installation location shown. ETL tested and certified

to comply with or exceed specified requirements.

a. NEC [CEC] - MPP/CMP (Plenum type locations and locations where not continuously enclosed inside conduit).

b. NEC [CEC] - MPR/CMR (Vertical riser type locations).

c. ANSI/TIA/EIA-568C; including related standards, amendments and TSB.

4. Electronic network systems infrastructure cables that are not installed inside conduit raceways. Electronic network systems infrastructure cables that are installed in concealed spaces including plenums and non-plenums; access floors, ceiling spaces, walls, floor, etc., and/or installed without continuous raceways. The cable insulation and jacket shall be listed and labeled "limited combustible cable" (LC or LCC) and shall comply with the latest published revision of all of the following additional requirements.

   a. Limited combustible "FHC-25/50" per UL-2424.

   b. NEC/CEC; CMP, additional listing/labeling where the install location is an environmental air plenum, "FHC-25/50-CMP".

   c. NFPA-90A; ceiling cavity plenums, wall cavity spaces and raised floor cavity plenums, limited-combustible.

   d. NFPA-5000; defines combustible material including wire and cable.

   e. NFPA-75 computer rooms and electronic equipment room.

   f. NFPA-13; spaces containing "limited combustible loading".

   g. Shall qualify as 100% recyclable materials disposal.

5. Cables installed in air plenums, air-handling spaces and cables installed without raceway or conduit shall also be UL listed and labeled for installation in air plenums.

6. The outer cable jacket shall be imprinted with date, manufacturer's model and catalog number and agency (AHJ) listing identification.

7. Cables installed in raceways or conduits below grade, through in-grade manholes and pull boxes shall be rated for installation in water/wet locations.

8. Copper wire Electronic Network Systems Infrastructure cable shall be a product of the same manufacturer, including portable patch cables.

9. The outer jacket of cables with less than 9-pair of conductors shall be color coded. The jacket color shall be different for each system type; multimedia; telephone/voice; computer/ data network; and fiber cable jackets.

10. 300-volt RMS insulation material for each data conductor shall be the same material; shall be the same electrical characteristics and shall be the same dielectric constant, for all data conductors contained within the respective common cable jacket, along the entire installed length of the cable. Data cables employing differing insulation materials for individual data conductors contained within a common cable jacket are not acceptable and shall not be provided.
11. Propagation and "Skew" Rate

a. Skew rate (nominal velocity of propagation delay) between any twisted pair in a combination of 4-twisted pair conductors grouped in the same cable, shall not exceed 35

nanoseconds between any wire pair contained in the conductor group, and as required by the cable Category rating, over a cable length of 328-feet (100 meters), for all frequencies up to the cable maximum frequency rating.

b. Nominal velocity of propagation, 70% of the speed of light.

12. Copper wire cables with more than 25-twisted pairs of conductors shall be constructed with 25-pair binder groups of conductors. The cable binder groups shall be enclosed in colored binders and assembled to form a single cable. The twisted pair/binder groups shall be enclosed with multi-layer dielectric protective sheaths underneath a cable jacket enclosing the entire cable assembly. A corrugated metal 100% shield shall be provided under the cable jacket enclosing all conductors.

B. Category-5E Computer/Data Enhanced Cables for Trunking Cable - UTP

1. Category-5E cables shall be tested and shall pass ANSI/TIA/EIA test recommendations for Category-5E Trunking Cables.

2. Operational characteristics:

a.	Wire size	24AWG solid copper (24AWG stranded copper for portable patch cables)
b.	Quantity of twisted pairs	As indicated but in no case less than 25-twisted pairs
c.	Impedance	100 OHM ± 15%, 3-100MHz
d.	Maximum Signal Attenuation per 300 feet (100 meters)	6.3dB @ 1MHz 13dB @ 4MHz 18dB @ 8MHz 20dB @ 10MHz 25dB @ 16MHz 28dB @ 20MHz 32dB @ 25MHz 36dB @ 31.25MHz 52dB @ 62.5MHz 67dB @ 100MHz
e.	Mutual Maximum capacitance of Any Pair	14pf/feet
f.	Worst Pair "NEXT" Loss Per/328-feet (100 meters)	62dB @ 1Mhz 53dB @ 4Mhz 48dB @ 8Mhz 47dB @ 10 44dB @ 16Mhz 42dB @ 20Mhz 41dB @ 25Mhz 40dB @ 31.25Mhz 35dB @ 62.5Mhz 32dB @ 100Mhz

C. Category-6 Computer/Data Cables – UTP

1. Category-6 cables shall be tested and shall pass the ANSI/TIA/EIA test recommendations for Category-6.

2. Operation Characteristics:

a.	Wire size	23AWG solid copper (23AWG stranded copper for portable patch cables)
b.	Quantity of twisted pairs	As indicated but in no case less than 4-twisted pairs
c.	Impedance	100 OHM ± 15%, 1-250Mhz
d.	Maximum Signal Attenuation Per 328-feet (100 meters)	2.0dB @ 1Mhz 3.8dB @ 4Mhz 5.3dB @ 8Mhz 6.0dB @ 10Mhz 7.6dB @ 16Mhz 8.5dB @ 20Mhz 9.5dB @ 25Mhz 10.7dB @ 31.25Mhz 15.4dB @ 62.5Mhz 19.8dB @ 100Mhz 29.0dB @ 200Mhz 32.8dB @ 250Mhz
e.	Mutual Maximum Capacitance of Any Pair	5.0nF/100m
f.	Worst Pair "NEXT" Loss Per/328-feet (100 meters)	74.3dB @ 1Mhz 65.3dB @ 4Mhz 60.8dB @ 8Mhz 59.3dB @ 10Mhz 56.2dB @ 16Mhz 54.8dB @ 20Mhz 53.3dB @ 25Mhz 51.9dB @ 31.25Mhz 47.4dB @ 62.5Mhz 44.3dB @ 100Mhz 39.8dB @ 200Mhz 38.3dB @ 250Mhz

2.3 FIBER OPTIC FIBER SPLICES

A. General

1. Fiber optic cable splices shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568B including related standards, amendments and TSB.

2. Fiber optic splices shall be the products of the same manufacturer.

B. Mechanical Splice

1. Mechanically splice each fiber with a splice suitable for use with the type of fiber optic fibers. Re-enterable and reusable splice. Splice shall be recommended as compatible with the optical fibers by the manufacturer. Splice shall not require the use of adhesives. Splice shall provide integral strain relief.

2. Performance requirements after installation:

   a. Operating temperature range minus 20-degrees centigrade through plus 60-degrees centigrade.

   b. Loss variation over temperature range, 0.05dB or less at specified wave lengths.

   c. Insertion loss, 0.3dB or less at specified cable wave lengths.

   d. Reflection (return loss), -40dB at specified cable wave lengths.

C. Fusion Splicing

1. Fusion splicing shall be performed with equipment providing the following features:

   a. Cleaving and cleaning optical fiber.

   b. Integral splice optimization verification system with local injection and detection.

   c. Projection screen optics and fiber core alignment system.

   d. Fiber cleaning/stripping.

   e. Cleaning fiber ends and fusing of fiber together with an electric arc.

2. Fusion splice insertion loss as measured at the completion of the splice shall be less than 0.1dB at specified cable wave lengths.

2.4 FIBER OPTIC FIBER CONNECTORS AND INTERCONNECTION COUPLERS

A. General

1. The connectors and interconnection couplers shall be compatible, maintain the same performance Category rating and be compatible with the corresponding fiber-optic cable type attached to the connectors.

2. Fiber optic cable connectors and interconnection couplers shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements. Connectors and couplers shall comply with ANSI/TIA/EIA-568C, related standards, amendments, TSB, and Fiber Optic Connector Intermate Standard (FOCIS) documentation.

3. Fiber optic connectors and couplers shall be the product of the same manufacturer.

4. Shall be UL listed and comply with UL94V-0.

5. Color code connectors for fiber optic cables to match the respective fiber optic strand/jacket color.

B. Single Mode and Multimode Fiber Optic Fiber Connectors

1. LC – Small Form Factor (SFF) termination connector:

a. Ceramic oxide 1.25mm ferrule. Mechanical durability not less than 500-mating cycles. Insertion loss of mated connector shall be less than 0.3dB at specified wavelengths.

b. Strain relief boot, long boot type unless indicated otherwise, short or angled boot type to match the connector installation application. Provide duct cover cap for each connector.

c. Locking type to automatically align mating fibers in the fiber cable and prevent accidental rotation and pullout.

C. FIBER OPTIC FIBER INTERCONNECTION COUPLERS

1. Interconnection couplers shall be “like-to-like” compatible, and shall provide "plug-in" coupling of two fiber optic cable connectors terminated with fiber optic fibers front-to-rear "in-line" together. The coupler shall provide interlocking, automatic optical self-alignment of two mating fiber optic connectors.

2. The centerline to centerline spacing of the interconnection couplers shall allow removal and insertion of portable patch cords, fiber cable connectors for both “single” and “duplex” type fiber adapter connectors without interfering with adjacent connectors.

3. Patch panel mounted interconnections couplers shall be factory pre-mounted to a modular nominal 0.09-inch thick metal panel, couplers aligned and anchored on the plate.

a. The metal panel shall be predrilled for standard EIA mounting in high-density 19-inches wide metal patch panel frames.

4. Interconnection couplers in workstation outlets shall be installed in outlet boxes with cover plates.

5. Provide removable dust caps for the front side of each coupler.

2.5 COPPER WIRE OUTLET CONNECTORS

A. General

1. Connectors shall comply with FCC part 68 Subpart F for gold plating.

2. Connectors shall be UL listed and shall comply with UL94V-0.

3. Provide a removable blank dust cover for each plug-in outlet insert. The dust cover shall protect the insert from contamination until a workstation or patch cord is "plugged" into the outlet.

4. Copper wire outlet connectors shall be color coded to distinguish telephone/voice separately from computer/data. The outlet cover plate shall be engraved to identify telephone/voice, computer/data and other infrastructure outlets separately.

5. Copper wire outlet connectors shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related standards, amendments and TSB.

6. Copper wire outlet connectors shall be the product of the same manufacturer.

B. Universal Outlet Connector (for twisted pair Copper Wire Premise/Workstation Wiring and copper wire patch panels).

1. General

a. Connections for twisted pairs copper conductors shall provide a universal outlet connector between the building premise copper wire, and plug-in workstation locations. Patch panel/equipment plug-in connectors. The connector components shall assemble with "snap-in" spring loaded retainers to prevent dislocation during insertion or removal of external plug-in devices.

b. The contacts shall be gold plated with a 250-insertion/withdrawal cycle rating.

c. Unless specifically noted otherwise the universal outlet connector shall comply with ANSI/TIA/EIA-568C; related standards, amendments, and TSB.

d. Operational characteristics shall match or exceed and shall be compatible with the respective twisted pairs cable.

e. Each universal outlet connector shall consist of three major components.

1) Universal edge connector assembly.
2) Plug-in adapter inserts.
3) Connector housing.

f. Provide snap-in blank removable insert covers for connector installed without plug-in adapter inserts.

2. Universal edge connector:

a. Insulated assembly shall connect to the premise copper wire. The connectors shall be multiple plug type connector contacts, one contact (total of 8 contacts) for each individual premise wire connection interconnected to the individual wire terminations.

b. Connector shall provide insertion of individual insulated copper wire, gas tight, 110-style punch down/displacement termination, for 22-26AWG insulated premise wire.

c. The edge connector assembly shall provide termination of eight (8) separate wire conductors, twisted or untwisted pairs, solid or stranded, shielded or unshielded, with color codes and numbered identification of each contact. Integral cable/conductor strain relief to prevent pullout of terminated premise wire conductors.

3. Plug-in adapter inserts:

a. Plug-in adapter inserts shall be internally factory connected to the universal edge connector assembly to adapt the universal connector to the specific outlet type configuration (i.e. "RJ" style computer/data, telephone/voice, (multimedia) modular jacks, etc.)

b. Inserts shall be certified to match premise wire type connected to the universal edge connector.

c. Inserts shall provide correct pin-to-pin connections, electrical and mechanical matching characteristics for the specific equipment connected to the respective outlet.

d. Inserts for different infrastructures shall be color coded with different colors from each other, for system identifications.

e. Plug-in adapter insert type:

1) Computer/data network systems:

a) ANSI/TIA/EIA-568C, female modular jack 8-position/contact "RJ-45" style, keystone, “snap-in” mounting.
b) Color:, blue.

2) Telephone/intercom voice systems:

a) ANSI/TIA/EIA-568C female modular jack 8-position/contact RJ-45, keystone, “snap-in” mounting.
b) Color: VOIP, blue. Non-VOIP, white.

4. Connector housing:

a. Connector housing shall contain the universal edge connector assembly and the plug-in adapter inserts in a rigid assembly. Connector housing shall provide integral cable strain relief for the premise wiring connection.

b. The connector housing shall mount to a metal panel, metal device cover plate or plastic device cover plate with spring loaded snap-in retainers. Nominal depth of connector housing behind the mounting panel and/or device cover plate shall not exceed 1.625 inches including premise wiring termination depth requirements.

2.6 FIBER OPTIC FIBER DISTRIBUTION ENCLOSURES

A. General

1. Fiber optic fiber distribution enclosures shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/ TIA/EIA-568C including related standards, amendments and TSB.

2. Fiber optic fiber distribution enclosures shall be the product of the same manufacturer.

B. Equipment Rack Mount Fiber Optic Termination Distribution Enclosure - RTDE

1. The RTDE enclosure shall mount in a EIA standard 19-inches wide enclosed or open frame equipment rack assembly. The RTDE enclosure shall be metal, painted finish, manufacturers standard color.

2. The RTDE shall provide the following self-contained functions internal to the RTDE assembly.

a. Fiber cable termination.

b. Fiber cable "pig-tail" splicing.

c. Fiber cable patch panel.

d. Fiber cable management, training and strain relief.

e. Individual fiber and patching port identification numbers, color-coding of incoming trunk

and out-going distribution fiber ports.

f. Plug-in fiber optic interconnection couplers for port to port patching with portable fiber optic patch cords.

3. Fiber splice drawers:

a. Horizontal sliding metal drawers adjustable to approximately 30 degree angle when fully open, and removable for easy access. Each drawer shall contain two (2) fiber optic splice trays with tray holders.

b. Drawers shall stack vertically one above the other in the RTDE and allow sufficient slack in all fiber cables for removal of the drawer and splice trays.

c. Provide one sliding drawer and two (2) splice tray assemblies for each group (twenty-four (24) individual fibers or fewer fibers per group) of fiber optic fibers terminated in the equipment rack, but in no case provide not fewer than two (2) sliding drawers with splice tray assemblies in each RTDE.

4.. Fiber cable patch panel

a. Metal panel shall provide a patch port for each fiber consisting of metal panel mounted fiber optic interconnection couplers for each fiber optic fiber indicated to be terminated at the RTDE.

b. The fiber optic fiber interconnection coupler shall be provided to match and be compatible with the fiber cable connectors. Quantity shall match quantity of terminated fibers, unless indicated otherwise on the equipment rack schedules.

c. Nominal panel thickness 0.09 inches.

d. Provide a minimum of sixteen (16) unused spaces for additional couplers in the patch panel.

5. Nominal height of the RTDE shall nor be exceeded, as follows:

Quantity of Patch Ports	Quantity of Splice Drawers	Nominal Height
24	2	11 inches
48	2	11 inches
72	3	14 inches
144	6	28 inches

C. Equipment rack mount fiber optic, splice only (for use only where fiber patch panel is not required) enclosure - RMSE

1. The RMSE enclosure shall mount in a EIA standard 19-inches wide enclosed or open frame rack assembly. The enclosure shall be metal, painted finish, manufacturer's standard color.

2. The RMSE shall provide the following self contained functions internal to the RMSE assembly:

a. Fiber cable splicing for "thru splicing" of fiber optic cables where the cables do not terminate in the equipment rack.

b. Fiber cable management, training and strain relief.

3. Fiber splice drawers

   a. Horizontal sliding metal drawers adjustable to approximately 30 degree angle when fully open and removable for easy access. Each drawer shall contain two (2) fiber optic splice trays with splice tray holders.

   b. Drawers shall stack vertically one above the other in the RMSE and allow sufficient slack in all fiber cables for removal of the drawers and splice trays.

   c. Provide one sliding drawer and two fiber optic splice tray assemblies for each group (24 individual fibers or fewer fibers per group) for fibers optic fiber routed through but not terminated in the equipment rack, but in any condition provide not fewer than two (2) sliding drawers with splice tray assemblies in each RMSE.

4. Nominal height of the RMSE shall not be exceeds, as follows:

Quantity of Thru Splices	Quantity of Splice Drawers	Nominal Height
24	2	4 inches
48	2	4 inches
72	4	8 inches
96	4	8 inches

2.7 COPPER WIRE PATCH PANELS

A. General

1. Copper wire patch panels shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related standards, amendments and TSB.

2. Copper wire patch panels shall be the product of the same manufacturer.

B. Equipment Rack Mounted Patch Panel

1. Standard EIA 19-inches wide metal panel, manufacturers standard color. Prepunched for copper wire outlet connectors. Panel shall mount on a EIA standard 19-inches wide enclosed or open frame equipment rack assembly. Nominal twenty-four (24)-copper wire outlet connectors in a horizontal row, quantity of rows as required for total quantity of connectors. Provide not less than two (2) spare empty rows for future copper wire outlet connectors.

2. The patch panel shall provide the following self contained functions.

   a. Copper wire cable termination including conductor/shield termination and strain relief.

   b. Plug-in copper wire outlet connectors for port to port patching with copper wire portable patch cords.

3. Patch panel height shall be based on the quantity of copper wire outlet connectors described plus the specified space for future outlets and shall not exceed the following dimension height:

Outlet Quantity	Nominal Patch Panel Height

48-patch ports in each patch panel	Shall not exceed 3.5-inches for each 48 port panel

4. Horizontally mounted, cable support metal bracket shall be provided for 48-outlet/connector groupings between fiber and copper wire. The brackets shall be bolted to the equipment rack located at the backside of the patch panel, the brackets shall support and provide strain relief for each incoming copper wire cable connecting to the patch panel left-right cable entrance pathway.

5. The copper wire connector installed in the patch panel shall be the same configuration, manufacturer and type as the corresponding copper wire connector provided in the remote workstation outlet locations connecting to the respective patch panel outlet, unless indicated otherwise.

2.8 EQUIPMENT RACK

A. General

1. An equipment grounding bus, nominal 19-inches long, UL labeled as a ground terminal bus, shall be provided on each equipment rack. The ground bus shall be bolted to the rack main metal frame member with 1-inch standoff non-insulating bolts. Provide a minimum of ten (10) drilled and tapped bolt holes in the ground bus with ground lug bolts, for connection of equipment grounding conductors to the ground bus size to accept ground conductors #14-#4AWG.

2. Vertically mounted, cable management metal rings (aluminum or stainless steel) shall be provided full height, continuously along the front of each vertical rail of the equipment rack. The rings shall be bolted to the equipment rack. The rings shall train and dress portable patch cords connecting between outlet connectors located in the equipment rack or in adjacent equipment racks.

3. The entire rack assembly including any support arms shall comply with seismic earthquake structural standards at the install location.

   a. The assembly shall provide support for the weight of the equipment installed on the rack, but in no case less than 500 pounds of equipment, plus the weight of the rack and connecting cables. A 2.0 times safety factor shall be included in the equipment rack assembly structural design.

   b. Mini-equipment racks shall be rated for not less than 200 pounds of equipment, plus a 2.0 times safety factor shall be included in the mini-equipment rack.

4. Provide Transient Voltage Surge Suppressor with RF Suppresser (TVSS) and Power Distribution Unit (PDU). 120-volt, 1-phase, 20-ampere 60Hz AC plug, horizontal strip,

   mounted in each equipment rack. Each unit shall contain not less than eight (8) “plug-in” on the rear of the TVSS and not less than two (2) plug-in on the front of the TVSS protected outlet plugs.

5. Mini-equipment racks shall have pre-drilled mounting holes the entire length of equipment vertical mounting frames, EIA-310D 19-inches (nominal) wide standard spacing for indicated equipment. Racks shall provide 17.75-inches (nominal) equipment horizontal mounting space between vertical rails.

6. Provide all floor standing equipment racks with wall bracket support arms extending from the stationary portion of the rack to adjacent wall. Provide "dual-rail arm" cable “runway tray”,

horizontally from each equipment rack, to the wall directly behind the equipment rack

a. The tray shall extend from and bolt to the top of the equipment rack “fixed” top rail.

b. The tray side rail arms shall be a minimum of 6-inches deep, with "ladder" type rungs spanning horizontally between the side rail arms. The rail arms shall be parallel with each other. The rail-to-rail arm spacing shall be the same as the equipment rack width.

c. The rungs shall be spaced not more than 6-inches on center between the side rails, along the length of the side rail arms. The rungs shall have a minimum cable bearing surface of not less than 0.75 inches, lengthwise along the tray.

d. The runway tray shall support a minimum of 200 pounds per linear foot live conductor/ cable loading, with not more than 0.25-inch deflection at mid-span.

e. Provide a continuous horizontal support “C” channel along the wall behind the equipment racks and bolt the dual-rail arm cable runway tray to the channel at the wall. The channel elevation on the wall above the finish floor shall support the runway tray horizontally (± 0.2 inch), from the equipment rack to the wall.

f. Equipment racks shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568B including related standards, amendments and TSB.

g. The wall mounted horizontal support channel shall be securely through bolt to wall structural member, a minimum of 16-inches on center. The horizontal support channel shall extend a minimum of 6-inches past each side of the runway tray. Support channels as manufactured by Unistrut-P1001C series; or B-Line; or Kindorf.

7. Provide a copper ground – bus for equipment bonding, in each equipment pack. Grounding lugs and hardware shall not block or interfere with equipment mounted in rack.

8. Equipment racks shall be manufacturer’s standard rust inhibitor primer. Manufacturer’s standard color-finish paint over primer, unless noted otherwise.

B. Fixed Position Floor Standing Open Frame Equipment Racks (indoor locations only):

1. Floor mounted self-supporting rack, nominal 78-inches (44U) of usable mounting frame height for equipment.

2. Bolted or welded hot dip galvanized steel or gold irradiate finish aluminum support frame. Hardware shall be stainless steel.

3. Open frame rack construction, fixed, non-swing gate.

a. “Two-post” style for equipment racks designated as NOT containing UPS equipment and NOT containing server equipment. Provide minimum 50 screws for each 2 post rack.

b. “Four-post” style for equipment racks designated as containing UPS equipment and/or server equipment. Vertical mounting rails shall have rectangular holes to accommodate cage nuts. Provide minimum 100 cage nuts and 100 screws for each 4 post rack.

4. Open frame equipment racks as manufactured by APC/Schneider.

5. Requirements for an MDF includes a minimum of one (1) 4-post server rack as defined above.

C. Mini-Equipment Racks Sectional – Surface Wall Mount (Indoor Locations Only)

1. The mini-equipment rack shall be fully metal enclosed, tamper resistant, wall surface mounted, multiple section construction. The rack shall consist of three (3) sections; a fixed wall mounting pan; a hinged center section and a hinged door. The rack shall provide a minimum of 30-inches clear internal depth for mounting of equipment inside the rack. Provide brackets inside the pan for stress relief, training/lacing, support of cables.

2. The mini-equipment racks nominal dimensions shall be as follows:

   a. Overall depth 33-inches.

   b. Overall width 22-inches.

   c. 24-inches minimum over all height, for termination of up to a quantity of 144-copper wire workstation patch panel outlets and up to a quantity of eighteen (18) individual fiber strands, combined into a mini-equipment rack.

   d. 30-inches minimum overall height, for termination of up to a quantity of 192-copper wire workstation patch panel outlets and up to a quantity of eighteen (18) individual fiber strands combined, into the mini-equipment rack.

   e. 48-inches minimum overall height, for termination of up to quantity of 288-copper wire workstation patch panel outlets and up to a quantity of eighteen (18) individual fiber strands combined, into the mini-equipment rack.

3. Fixed wall, surface mounted pan section, nominal 3-inches pan depth, metal enclosed on all sides and back, open front; shall anchor the rack to the wall; provide support for the hinged center rack section and provide knockouts for side/top/bottom and rear conduit/raceway entrances.

4. Center section, metal enclosed on all sides, open front and rear, nominal 18-inches depth, full height and width hinged attachments to the pan-section, to provide hinged 90 degrees open-close operation of the center section on the pan and allow access to the front and rear of equipment and terminations mounted inside the center section. Two (2) internal vertical, front mounted, pre-drilled equipment mounting frame rails. Self-locking with release latch accessible from inside cabinet.

5. Front access door section, metal, full height and width hinged 90 degree open-close operation attached to the center section. The door shall allow for nominal 3-inches minimum of interior projections extending from the front face of the internally mounted equipment located behind the front access door when the access door is in the closed position. Smoke/ gray impact resistant, tamper resistant see-through windows in the door front. Key-locking front of door exterior access.

6. Minimum sixteen (16) gauge metal, fully welded construction; Manufacturer's standard rust inhibitor "prime" base coating, with "finish" color black or as selected by Architect. The equipment racks shall provide support for the weight of the equipment installed in the rack, but in no case less than 200 pounds of equipment plus the weight of the rack and connecting cables.

7. Provide two (2), 120 volt 60Hz AC motor direct driven air ventilation, "muffin" style, nominal 4 inches square, exhaust air fans. Flush mount fans in the top of each equipment rack. The fans shall be low speed, low noise type with wire guards to prevent accident contact with the fan blades. The fan motor shall be high impedance, self protecting type motors. Provide "SO" cord with plug caps to connect from the fans to the 120-volt plug-strip inside the

equipment rack.

8. Provide cooling air intake louvers with removable air filters and air filter holder, mounted in the bottom of the rack. The louver shall be protected with internal screening to prevent the intentional insertion of foreign objects into the housing.

9. The mini-equipment rack shall be easily convertible in the field, to allow for “left” or “right” center section and/or door section hinge operation. Provide a minimum of two (2) key-locks on each hinged section to prevent unauthorized access into the unit. Provide gasketing on all “mating” cabinet interfaces to insure proper cooling airflow through the air filters.

10. Mini-equipment racks as manufactured by Hoffman/Pentair; or Middle Atlantic Products Inc..

D. Plug Strip Transient Voltage Surge Suppressor (TVSS)

1. General

a. Self contained unit combining plug-in TVSS strip and power distribution unit PDU. Rated 20 ampere, nominal 120 volt +10%, 60Hz, AC, 2400 watts full continuous load or 20 ampere, nominal 208-volt ± 10%, 60Hz, AC, 4800-watts full continuous load. Note: 120-volt or 208-volt ratings as indicated on the Drawings.

b. Internal 20 ampere resettable overload protection circuit breaker. Red illuminated on-off switch. Nine foot, 12AWG three (3) conductor grounded, high abuse heavy duty jacketed AC, line cord with cap. Multi-outlet receptacles, suitable for use with the following types of plug in loads; data processing equipment, audio/video equipment, test instruments, medical equipment, photo graphic equipment and “switching type” power supplies.

c. Protected outlet shall be 120-volt NEMA 5-15R 15 ampere, or 20 ampere 120-volt NEMA 5-20R AC 60Hz receptacles; or for 208-volt, NEMA 6-15R 15 ampere or 208-volt NEMA 6-20R 20 ampere receptacles as applicable for connected equipment loads. Provide not less than eight (8) protected outlet plugs on each unit. Each individual or group of two (2) receptacles (duplex) shall be connected to separate protected load isolated filter banks.

d. Each duplex shall be isolated from the other output receptacles, minimum isolation of 25dB at 1MHz line to line, line to neutral, line to ground and neutral to ground.

e. Non-blocking plug-in locations/orientation, for plug-in self-contained “power-brick”, equipment power supplies.

f. As manufactured by Liebert; or TRIPP LITE.

2. Operation

Self-contained RFI and EMF shielded housing with mounting slots for temporary mounting of the unit. Protected outlet receptacles shall supply over current protected and filtered, electrical line voltage power to the connected equipment. Line noise RFI and EMI interference filtering suppression, transient voltage surge and spike protection shall occur in all three (3) modes of operation line to ground, line to neutral and neutral to ground rated as follows:

a. 13,000 ampere, 210 joules (watt-seconds) peak withstands capacity.

b. Transient response time less than five (5) nano seconds.

c. 140-volt AC RMS spike suppression 330 volt maximum let through.

d. RFI and EMI Suppression-Provide spectrum analysis test dB attenuation reports showing RFI filtering over specified frequencies.

e. Diagnostic indicator lights located on the TVSS housing shall provide alarm alert for each of the following conditions:

1) Loss of AC power.
2) Damage, malfunction in the TVSS suppression circuits.
3) Improper AC electrical outlet wiring.

f. Self contained metering and communications

1) Ampere-meter demand load meter to monitor plug-in demand load.
2) Digital Fast Ethernet LAN RJ-45 communications port for Ethernet SNMP network monitoring of electrical status. Multi-user site wide software license, compatible with PC-computer and IP-WEB HTTP protocols.

g. Standards Testing, Listing and Certification Compliance:

1) IEEE 587A and B compliance.
2) UL 1449 transient voltage surge suppressers.
3) UL 1363 temporary power taps.
4) UL 1283 electromagnetic interference filters.

3. Rack Mounted TVSS/PDU

a. TVSS/PDU units installed in equipment racks shall comply with all of the same performance requirements including as follows.

1) EIA/TIA – Equipment rack mount style (19-inches or 24-inches as applicable).
2) Minimum of two (2) front mounted outlets and not less than six (6) rear mounted outlets.
3) Position in each equipment rack as directed by Owner's Representative.

E. Power Distribution Unit (PDU)

1. General

a. Self-contained unit combining main circuit breaker, multiple plug-in individual circuit breaker branch protection load receptacles, PDU metering status monitoring and network communication. All PDU components self-contained in a NEMA-1 metal enclosure.

b. Non-blocking plug-in locations oriented for plug-in self contained "power-brick" equipment supplies.

c. Standards Testing

1) UL 60950-1 Information Technology Equipment.
2) CAN/CSA-C22.2 No.60950-1-03 Information Technology Equipment.
3) FCC, Title 47, Part 15 Subpart B for Class B operation as defined by ANSI Standard C63.4
4) ROHS Complaint
5) ISTA Procedure 1A and 2A

d. Shall be a product of the same manufacturer as the Owner's UPS equipment and shall be monitored by Owner's existing software.

2. System Description

   a. Remote monitoring and/or control capabilities for power distribution at each load/ equipment rack level. For data/network equipment line voltage plug-in and TVSS line voltage plug-in electrical distribution.

   b. PDU shall meter and monitor electrical attributes of an individual Rack PDU, including real-time remote and local display of monitoring of aggregate and branch electrical parameters (status, thresholds, alarms) including voltage, ampere, and kW. Rack equipment PDU and Branch load monitoring and control.

   c. Self contained metering and communications

      1) Local display ampere-meter demand load meter to monitor plug-in demand load and total PDU load.
      2) Digital Fast Ethernet LAN RJ-45 communications port for Ethernet SNMP and IP network monitoring of electrical status. Must be the same brand as the Owner's existing UPS and monitoring software..

   d. Nine foot input power (heavy duty high abuse) cord with appropriate conductors and input NEMA plug-in connection. Provide input overload protection with Hydraulic-Magnetic main input circuit breaker. Provide load output NEMA plug-in branch connection with overload circuit breaker protection for each load receptacle.

   e. Wall mounted equipment rack mounting uses horizontal position form factor.

   f. Floor mounted equipment rack mounting uses vertical position form factor.

3. Electrical Power ratings shall be as follows and as additionally indicated on drawings. Refer to drawings for twist-lock verses straight-blade configurations.

   a. Single main input circuit breaker 30 ampere 208/120 volt 1-phase 4-wire grounded 60Hz AC.

   b. Branch load circuit breakers with a single plug-in receptacles for each load circuit breaker. Balance loads on each circuit phase.

      1) Three (3), 20 ampere 1-pole circuit breaker and three (3) 120-volt NEMA 5-20R receptacles. Also provide matching cap.
      2) Two (2), 20 ampere 2-pole circuit breaker and two (2) 208-volt NEMA 14-20R receptacle. Also provide matching cap.
      3) One (1), 30 ampere 2-pole circuit breaker and one (1) 208-volt NEMA 14-30R receptacle. Also provide matching cap.
      4) Additional circuits and receptacles as indicated on drawings.

4. PDU units installed in equipment racks shall comply with all of the same performance requirements including:

   a. EIA/TIA – equipment rack horizontal mount style (19-inch or 24-inch) as applicable.

   b. Position in each equipment rack as directed by OWNER's Representative.

5. Provide two (2) Category-6 4-pair UTP 15-foot long portable patch cable connects, PDU to respective network patch panel port.

F. Power Outlets for Mini Racks

1. Power outlets for Mini rack equipment shall be installed inside the rack. They will be located on the rear panel in the lowest corner nearest the side with the cabinet hinge.
   a. Provide 1 L6-20R 250V 20A receptacle for emergency power circuit.
   b. Provide 1 duplex 120VAC 20A receptacle.

2.9 WALL MOUNT FIBER OPTIC CABLE INTERFACE CABINET (WMIC)

A. General

1. Metal (14 gauge) enclosure, with full height hinged metal door. Door shall be pad-lockable. Nominal size 12-inches deep by 18-inches wide by 36-inches high. Enclosure shall mount directly on the wall.

2. WMIC shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related standards, amendments and TSB.

3. Interface cabinets shall be the product of the same manufacturer.

B. The WMIC shall provide the following self contained functions internal to the WMIC enclosure.

1. Fiber cable splicing for "through splicing" of non-UL listed fiber optic cables, where the cables do not terminate in the building.

2. Fiber cable management, training and strain relief.

3. Transition from non-UL flame spread listed fiber optic cable, to UL flame spread listed fiber optic cables where the cables terminate in the building.

C. Cable routing rings shall organize optic fibers in a 360-degree loop inside the WMIC housing and provide cable strain relief.

D. Fiber Optic Splice Trays

1. Provide fiber optic cable splice trays.

2. Tray holders shall provide mounting and support for each splice tray.

3. Provide two (2) splice tray for each group (twenty-four (24) or less fibers per group) fiber optic fibers routed through the WMIC, but in no case provide not less then four splice trays in the WMIC.

2.10 SPLICE TRAY FIBER OPTIC FIBERS

A. General

1. Trays shall be suitable for installation in USE, WMIC, RMSE and RTDE enclosures.

2. The trays shall be the product of the same manufacturer as the respective enclosures.

3. Splice trays shall be UL listed, complying with national Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related standards, amendments and TSB.

B. Splice Trays

1. A metal or non metal splice tray shall provide space for up to twenty-four (24)-splices of individual fiber cable single mode and multimode optical fibers. The trays shall provide individual splice holder inserts for each splice to adapt the tray for mechanical or fusion splices, with or without splice sleeves.

2. The tray shall incorporate integral fiber tie down clamps, fiber routing rings, provide strain relief and two full 360 degree fiber loops around the tray perimeter with sufficient slack fiber for removal of the tray for access and splicing of the fiber cable. The tray shall insure the minimum bending radius of the optical fibers is not violated.

3. Provide a removable clear plastic tray top cover for each tray, to protect and isolate the fibers.

2.11 WORK STATION OUTLETS

A. General

1. Engrave outlet cover plates with the port number corresponding to the port number at the respective terminal block, patch panel, or head-end equipment.

2. The outlet cover plates shall be factory pre-punched and formed to accommodate the installed outlet connector with attachment screws.

3. Workstation outlets shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related standards, amendments and TSB.

4. Work station outlets shall be the product of the same manufacturer.

B. Computer/Data Workstation Copper wire Outlets

1. The outlets shall be the same configuration and type as the corresponding connector provided in the copper wire patch panel outlet, unless noted otherwise.

2. ANSI/TIA/EIA-568C, and related standards, addendums and TSB.

3. The copper wire outlet connectors for twisted pair wire connections in computer workstation outlets shall be universal outlet connector RJ-45 type, Category 6.

4. All outlet connectors located above the ceiling grid in a room shall be terminated in one location within a standard electrical 4S box, or as determined by Owner. “Biscuit” jacks are not allowed.

C. Telephone/Voice Handset Twisted Pair Wire Connection Work Station Outlets

1. The copper wire outlet connectors provided in telephone/voice handset outlets, shall be universal outlet connector type, unless noted otherwise, ANSI/TIA/EIA-568C and related standards, addendums and TSB.

   a. RJ-45 type

D. Fiber Optic Workstation Outlets

1. The fiber optic outlet connectors workstation outlets shall be fiber optic fiber interconnection

couplers, installed in universal outlet connectors. Provide one (1) coupler for each fiber connecting to the outlet, but in no case less than the following for each outlet and as shown on the Drawing:

a. Computer workstation data network- two (2) couplers and fiber connectors.

b. Data network server - four (4) couplers and fiber connectors.

2. The universal outlet connector housing and cover plates shall be the same as copper wire outlet connectors, except with adapters for fiber optic interconnection couplers, for the fiber optic fibers plug-in connectors.

3. The centerline-to-centerline spacing of the interconnection couplers shall provide for "plug-in" insertion of “single or duplex” fiber connectors.

4. Color-code and identify the "in"-receiving and "out"-transmitting position for each interconnection coupler.

E. Outlet Boxes

1. Wall mounted

a. Flush or surface wall mounted outlet box as indicated on the drawings, but in no case less than 4.69 inches by 4.69-inches by 2.125-inches deep.

b. 2-gang wide extension ring for outlet box to extend outlet flush with finish surface, or as noted on the drawings.

c. 2-gang wide cover plate or as noted on the drawings.

2. Pedestal Mounted "Poke-Thru".

a. Shall combine a computer/data and a telephone/voice copper wire universal outlet connector in a duplex outlet in the pedestal/poke-thru outlet.

3. Inside flush floor boxes and other locations where indicated in the contract documents.

F. Multioutlet Raceway Work Station Outlets

1. Copper wire outlet:

a. Where copper wire connection is indicated for the workstation outlet, provide one universal outlet connector for each outlet.

b. Each universal outlet connector shall be single connector housing type.

c. Provide a rectangular cutout and metal device plate in the raceway sized to outlet manufacturer's recommendations. The workstation copper wire outlet shall mount a modular faceplate kit with outlet bezel and faceplate sized to match the workstation outlet.

d. Offset the location of outlets for electronic network systems 6 inches in the raceway from other outlets, do not "stack" outlets one above the other in the raceway.

2. Fiber optic outlet: Consult Owner.

2.12 PORTABLE PATCH CORDS

A. General

1. Provide portable patch cords for all copper wire and fiber optic cable infrastructure outlets:

   a. For interconnecting electronic network equipment to electronic network workstation outlets.

   b. For interconnecting equipment rack patch panel outlet patch locations with each other.

   c. For interconnecting patch panel outlets equipment rack mounted hubs, switches, routers etc.

2. Patch cords shall be factory assembled tested and certified with factory terminated plugs at each end. Field terminated portable patch cords shall not be permitted. Terminated plugs shall incorporate integral bending radius limiting molded “boots” and strain relief. Patch cord assemblies shall be rated for "heavy duty", “high-abuse” service.

3. Patch cords shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements. ANSI/EIA/T1A-568C, related standards, addendums and TSB.

   a. NEC and CEC - OFNG/OFN for fiber optic portable patch cords.

   b. NEC and CEC - MPP/CMP/CMR/CMG/MPG for copper wire twisted pair portable patch cords.

4. Patch cords which are not installed shall be delivered to the OWNER in cardboard boxes. The patch cords shall be neatly bundled and tied together. Mark each box with quantity and type of cords contained in the box.

5. Patch cords shall comply with the same cable communication Category-6 performance requirements, protocol requirements and testing requirements as the respective infrastructure cables and outlets to which the patch cords are intended to be connected (plug-in).

6. The outer jacket of each portable patch cord shall be imprinted with date, manufacturer’s model and catalog number, and AHJ listing identification.

B. Copper Wire Portable Patch Cords

1. Computer/data and telephone/voice patch cords, general:

   a. "Male" eight (8) position modular "RJ" male style jacks install on each end of the patch cord cable. The jack shall be provided with a rear "hinged boot" to prevent the plug tab from snagging when pulled backwards through adjacent wiring.

   b. Patch cord cable shall be UTP to match premise wiring, 4-pair twisted, stranded copper individually insulated wires, thermoplastic jacket over all the wires and shield.

   c. Connectors shall comply with FCC 68.5 and Part 68 Subpart F.

   d. Connectors UL listed and shall comply with UL-94V-O.

   e. Contacts gold plated with not less than a 750 insertion/withdraw cycle rating.

f. Provide RJ-45 connector feed patch cord cables for both computer/data and telephone/ voice copper wire patch cords.

2. Portable patch cord quantities and lengths for connecting port-to-port equipment rack patch panels. Typical for computer/data and telephone/voice.

   a. Patch cord quantity: Provide one (1) complete patch cord assembly for each copper wire workstation outlet port in the equipment rack patch panels. One-to-one straight through pin-to-pin wiring. Additional spare not required by OWNER. Cable jacket color shall be blue, except Wireless Access Points shall be purple, phones shall be white, and cameras shall be yellow.

   b. Provide the following lengths of copper wire patch cables for copper wire equipment rack patch panel outlets.

      1) 1 foot long - 90% of total quantity
      2) 4 feet long - 10% of total quantity

3. Portable patch cord quantities and lengths for connection from workstations equipment to equipment workstation outlets. Typical for computer/data and telephone/voice.

   a. Patch cord quantity: Provide one complete patch cord assembly for each copper wire workstation outlet located remote from the equipment rack patch panels. Provide additional spare patch cords, quantity equal to 15% of the total quantity of patch cords provided for each copper wire workstation outlets. Cable jacket color shall be blue.

      1) Network outlet segments the pin-to-pin patch cord wiring configuration and jacks shall be compatible with the network interface card, and workstation outlet.
      2) Telephone outlet segments the pin-to-pin patch cord wiring configuration and jacks shall be compatible with the telephone interface protocol and workstation outlet.

   b. Provide the following lengths of copper wire patch cables for copper wire workstation outlets. The patch cords shall provide internal cross-over wiring to conform the pin-to-pin connections required between the workstation outlet and the communications protocol interface card installed in the respective workstation equipment:

      1) 8 feet long - 30% of total quantity
      2) 15 feet long - 65% of total quantity
      3) 25 feet long – 5% of total quantity

4. The OWNER will furnish additional portable patch cords for modification, installation, and connection of patch panels to trunking cables by the CONTRACTOR.

C. Fiber Optic Portable Patch Cords

1. General

   a. Provide fiber optic fiber connectors installed on each fiber end of the patch cord cable. The fiber optic portable patch cord shall be “duplex” with two fiber strands type, for each patch cable. The “LC” connector shall be mechanically and optical compatible with the respective connecting patch panel couplers and network work equipment couplers.

   b. The entire patch cord assembly total insertion loss shall be less than 1.0dB at the specified operating wavelengths.

c. Operating temperature range minus 30 degrees centigrade through plus 60 degrees centigrade.

Cables shall be flame retarding.

d. Each fiber shall be individually identified with factory color coding and factory imprinted label. The outer cable jacket shall be imprinted with date, manufacturer's model and catalog number, along with agency listing identification. The cable jacket color shall be yellow standard color.

e. All fiber optic patch cord cable shall be a product of the same manufacturer.

f. Optical fiber shall be coated, 900 micron diameter uniform coating, with uniform tight buffering over the coating, uniform dielectric strength member surrounding the buffering coating and an overall jacket around each optical fiber assembly.

g. A dielectric strength member shall surround the fiber assemblies.

h. An outer dielectric jacket shall envelope the entire cable.

i. The cable shall be UL listed and comply with NEC and NFPA requirements for each installation location shown in the Contract Documents.

j. Patch cord quantity and length

1) Patch cord quantity: Provide one complete patch cord assembly for each fiber optic patch panel outlet in the equipment rack.
2) Provide one complete patch cord assembly for each computer workstation fiber optic outlet remote from the patch panel.
3) Provide additional spare patch cords, quantity equal to 25% of the total quantity of patch cords provided.

k. Provide the following quantities and lengths of fiber optic patch cords.

1) 3 feet long - 40% of total
2) 6 feet long - 30% of total
3) 10 feet long - 30% of total

2. Multimode patch cords

a. Patch cord cable shall be fiber optic cable with equal or better characteristics as the premise fiber optic cables.

3. Single mode patch cords:

a. Patch cord cable shall be fiber optic cables with single mode optical glass fibers, and with equal or better characteristics as the premise fiber optic cables.

2.13 CIRCUIT PROTECTORS

A. General

1. The circuit protectors shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related standards, amendments and TSB.

B. Circuit Protectors

1. Cables containing non-dielectric electrical conducting components entering from the exterior of the building shall be provided with individual circuit protectors combining both lightning circuit protection and TVSS circuit protection on each circuit conducting component, as required in NEC and CEC Articles 770 and 800.

2. Install circuit protectors in the respective backboard/equipment rack where copper wire conductors terminate, connect each protector to room/closet ground bus equipment with #10AWG green insulated bond/ground copper conductors.

2.14 TRUNKING CABLE TERMINAL BLOCKS

A. General

1. Terminal blocks Type 110, shall consist of wiring blocks, connecting blocks, direct wire/patch cord cross connection and designation strips. Arrange in unitized, modular, vertical mounting sections, for trunking cable Category – 5E.

2. Completely 100% front accessible for cross connections, terminating conductors, training, and fanning of cables. Rear access for any reason shall not be permitted.

3. Terminal blocks shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements. Terminal blocks and connections performance shall comply with ANSI/TIA/EIA-568C and related standards, addendums and TSB and shall comply with and be listed under UL 1863. Category rating shall match the cables connecting to the patch panel.

4. The trunking cable terminal blocks shall provide cross connection of four (4) pair premise copper wiring outlets to multiple copper wire trunking cable feeder cables and external free standing equipment.

5. Each full height vertical section terminal block assembly shall terminate a minimum of 300 pairs (including specified spares for future construction phases) of trunking cable conductors, plus associated cross connection wiring and patch cords in a nominal 20-inches wide space. Provide multiple vertical sections of terminal block assemblies adjacent to each other, total quantity as required for quantity of conductor pairs and feeder cable pairs shown on the drawings and requirements, plus specified spares.

6. Each terminal block vertical section assembly shall provide not less than 15% of spare unused conductor pair terminals for future connections.

7. Provide a common ground bus in each terminal block section with a minimum of six (6) ground conductor termination positions, #10AWG through #6AWG.

8. Terminal blocks shall be the product of the same manufacturer.

B. Wiring Blocks

1. One piece molded, die-electric thermoplastic blocks. The wiring block shall support and secure all the components of the terminal block assembly, and provide cable/conductor training and organization.

2. Fire retardant complying with UL 94V-0.

3. Standoff type support legs for mounting to backboard with pre-drilled anchor holes.

4. Non-conductive electrically quiet front assembly.

5. Horizontal index strip rows, for termination of not less than 25-conductor pairs on each row. Color-coded and marked in groups of four pairs or five pairs to match connecting cables.

6. Removable retainers at the ends of each horizontal connecting block index strip row, shall support cross connect wires at corner turns.

7. Distribution rings shall retain cross connect wire horizontal routing between terminations.

8. A full width, horizontal trough between each 100-pair wiring block shall provide a path for patch cord training and retention.

C. Connecting Blocks

1. Connecting blocks shall provide gas tight conductor electrical connections with conductor insulation displacement punch down slots, for insertion onto the telephone/voice wiring block index strips.

2. Connecting blocks shall electrically connect one-to-one between each conductor terminated at the wiring block index strips, and each cross connect/patch cord conductor terminated/ connected to the opposite front side of the connecting block.

3. Both sides of the connecting blocks shall terminate pairs of UTP 22-26AWG stranded or solid copper wire individually insulated conductors. The front side of the connecting blocks shall also provide "plug-in" connections for portable patch cords, 110-style "plug-in" connectors.

4. Connection blocks shall be 4-pair insulated copper conductor type.

5. Provide insulated, removable termination caps for each connector block.

6. Connector blocks shall be marked to indicate tip and ring conductors and to indicate polarization.

D. Designation Strips

1. Designation strips shall provide retention of interchangeable labels. The labels shall show circuit identification of each terminated conductor pair.

2. The designation strips shall mount on the center and outside positions of the wiring block.

E. Trunking Cable Cross Connection

1. The cross circuit connection between incoming and outgoing feeder cables and outlet wiring shall be provided in the terminal block assembly.

2. The cross connection wiring shall terminate incoming and outgoing circuit conductors between respective connecting blocks.

   a. Direct connect cross connection shall provide internally wired one-to-one conductor twisted pair cross connection. Cross connection of each 4-pair outlet cable to corresponding 4-pairs of the device feeder cable and cross connection of feeder to feeder trunking cables, as applicable.

b. Patch panel cross connect, 110-terminal connector style, plug-in. One, two, three or four twisted pair, 110-connector type portable patch cords will be furnished by the OWNER for CONTRACTOR modification, install and connect.

2.15 BACnet / Crestron Integration

A. General

1. Owner provided Crestron PRO3 Control System

2. Owner provided 3-Series® BACnet™/IP Support license (SW-3SERIES-BACNET-50+)

3. Installation of Control System will be in the MDF equipment rack

PART 3 - EXECUTION

3.1 NETWORK CABLE TESTING AND COMMISSIONING (ADDITIONAL REQUIREMENTS)

A. General

1. In addition to the testing recommended in ANSI/TIA/EIA-568C and related standards, amendments and TSB. End-to-End test 100% of all individual optical fiber, individual copper wire conductors, each outlet and each connector in all terminated and un-terminated cables, portable patch cord, outlets and patch panels provided in the contract, shall be tested after installation as a complete channel pathway installation, splicing outlets and termination is completed, including the following tests;

   a. Each circuit insertion loss.

   b. Each circuit NEXT (Pair-to-Pair) loss.

   c. Each circuit NEXT loss (Power Sum) PS.

   d. Each circuit ELFEXT loss (Pair-to-Pair).

   e. Each circuit ELFEXT loss ((Pair-to-Pair).

   f. Each circuit ELFEXT loss (Power Sum) PS.

   g. Each circuit return loss (RL).

   h. Each circuit propagation delay.

   i. Each circuit propagation delay-skew.

2. The test equipment and (tester) shall comply with the accuracy requirements for field testers as defined in the ANSI/EIA/TIA standards for the specific cable type. The tester including the appropriate interface adapter shall meet the specified accuracy requirements. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy. The tester shall be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor.

3. The Pass or Fail condition for the channel pathway link-under-test is determined by the results of the required individual tests (ANSI/EIA/TIA) any Fail result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass. A Pass or Fail result for each parameter is determined by comparing the measured values with the ANSI/EIA/TIA test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field test. The field test manufacturer shall provide documentation as an aid to interpret results marked with asterisks.

4. Provide all test equipment, certified testing personnel, and setups. Shall comply with ANSI/EIA/TIA and equipment manufacturer's recommendations and standards of practice.

5. Provide six (6) copies of all test reports, bound in three (3) ring binders and three (3) copies digital CD/DVD format using Adobe Portable format software, to Owner's Representative.

6. The CONTRACTOR shall repair or replace equipment, cables, outlets, connectors, splices, terminations, etc. identified during testing as not complying with the contract documents, without additional cost to the contract. Retest all replaced or repaired components at CONTRACTOR'S expense.

B. Twisted Pair Copper Wire Testing

1. Channel insertion loss (dB).

2. Channel near-end cross-talk NEXT loss (dB).

3. Channel equal-level far-end cross-talk ELFEXT (dB).

4. Channel return loss (dB).

5. Channel power sum PSACR (dB).

6. Channel propagation delay, propagation speed, and delay skew.

7. Channel wire map and circuit length.

8. Channel ring-out test for continuity and correct point-to-point matching terminals.

9. Channel DC resistance and capacitance.

10. Channel attenuation-to-cross-talk ratio ACR.

C. Coaxial Cable Testing

1. Channel full specified frequency spectrum attenuation insertion loss (dB).

2. Channel wire mapping, ring-out and circuit length.

3. Channel propagation delay and propagation speed.

4. Channel impedance and continuity for center conductor and shields.

D. Fiber Optic Cable Testing, Optical Testing for Each Specified Wave-Lengths for Both laser and LED sources.

1. Channel link insertion losses (dB).

2. Channel loop-back attenuation (dB).

3. Channel signature optical time domain reflectometer OTDR, for installation characterization testing (event and attenuation resolution dead zone at specified wavelengths, shall be less than 10-feet).

4. Channel continuity and correct point-to-point matching terminals.

5. Channel propagation delay and propagation speed.

6. Channel fiber optic mapping, circuit length, and tracing.

3.2 FIBER OPTIC CABLE TYPE

A. General

1. Cables shown as fiber optic type shall comply with the following installation locations.

2. Provide matching compatible outlets and terminate all fiber optic cables into matching fiber optic connectors.

3. Provide matching compatible outlets and terminate all fiber optic cables into matching outlet fiber optic connectors.

B. Provide loose tube gel filled or indoor/outdoor type fiber optic cable for any of the following installation location conditions.

1. Inter building (between buildings).

2. In a conduit or raceway located underground below grade.

3. In an exposed outdoor conduit or raceway not located underground or below grade.

4. Do not install loose tube gel filled type fiber optic cable inside a building or exposed on a building without providing rigid steel (RGS) conduit raceway for the loose tube gel filled fiber optic cable along the entire length of the cable inside or on the building located above finish grade.

C. Provide tight buffered or indoor/outdoor type fiber optic cable for any of the following installation location conditions.

1. Intra-building (inside a building) where raceway continuously encloses the cable and the raceway is not located underground, below grade.

2. In an exposed outdoor conduit or raceway not located underground or below grade.

D. Provide plenum rated type fiber-optic cable insulation for any of the following installation location conditions. Additionally, Cables shall be rated Limited-Combustible (LC) type UL FHC-25/50.

1. In any air plenum (supply or return) when a conduit or enclosing raceway is not provided for the entire cable length.

2. Where the cable is installed without a conduit or the cable is not fully enclosed in a raceway along the entire cable length in a building.

E. Optical Fiber Quantity:

1. The minimum fiber quantities in each fiber optic cable shall be as follows, but in no case less than indicated on the drawings.

2. Between main IDF (SUB-MDF) in separate buildings and the MDF main terminal rack fiber optic patch bay for the entire site/campus.

   a. Six (6) optical fibers, multimode and twelve (12) optical fibers, single mode.

3. Between satellite IDF terminal rack fiber optic patch bays and the main terminal rack IDF (sub-MDF) patch bay located in the same building.

   a. Six (6) optical fibers, multimode and twelve (12) optical fibers, single mode.

4. Between a terminal rack patch bay (IDF or MDF):

   a. To an individual workstation outlet located inside the same building - two (2) multimode optical fibers, (typical only for locations where fiber is specifically shown on the drawings for the specific work station outlet).

   b. To each network file server outlet location whether or not shown on the drawings, four (4) optical fiber, multimode.

5. Other locations as indicated on the drawings or described in the contract documents.

3.3 COPPER WIRE CABLE TYPE

A. General

1. Cables shown as copper wire type shall comply with the following installation conditions, unless noted otherwise on the drawings.

2. Provide matching compatible outlets and terminate all copper wire cables into matching copper wire connectors.

B. Cable Types and Quantities - Cable types and quantities shall be as follows unless specifically noted otherwise on the drawings. The following minimum type and quantity of copper wire cables from each individual workstation/device outlet, to the respective terminal equipment patch panel/ bay, (unless specifically noted otherwise), but in no case less than what is shown on the drawings and in no case less than one (1) 4-pair cable to each outlet “Jack” position:

1. Category-6, UTP 4-pair cable:

   a. Each network workstation outlet location. Color: blue. Minimum length: 10 feet.

   b. Each network “wireless-access-point” outlet location. Color: purple.

   c. Each network camera outlet location. Color: yellow

   d. Each desk mounted VOIP telephone handset (instrument) workstation outlet location. Color: white. Minimum length: 15 feet.

2. Trunking cable (Category-5E):

a. Between each separate buildings, 50-pair UTP cable.

b. Between each IDF's and/or MDF's in the same building 25-pair UTP cable.

C. Provide plenum rated copper wire cable insulation for any of the following installation location conditions. Additionally, cables shall be rated Limited-Combustible (LC) type UL FHC-25/50.

1. In any air plenum (supply or return) when a conduit or enclosed raceway is not provided for the entire cable length.

2. All locations where the cable is installed without a conduit or the cable is not fully enclosed in a raceway along the entire cable length in the building.

3.4 CABLE INSTALLATION

A. General

1. Cables connecting to equipment racks and terminal blocks shall be installed with not less than 6-feet of slack cable between the equipment rack/terminal block and terminal backboard. The slack cable shall be coiled and supported on the backboard and/or cable tray.

2. Cables in terminal closets and terminal rooms shall be trained, dressed and racked on the plywood backboards. Provide cable, metal support arms and re-enterable type cable support rings not less than 12-inches on center mounted onto the plywood along the entire length of all cables.

3. Provide separate routing paths on plywood backboards for fiber-optic cables, computer data and copper wire cables and telephone/voice copper wire cables and multimedia, audio/video, TV cables. Provide separate routing paths on plywood backboards for shielded copper wire cables and unshielded copper wire cables.

4. Cables shall be routed parallel to floors and walls. Do not route cables diagonally on backboards.

5. Spare cable slack

a. Provide 25-feet of spare cable slack where unterminated cables are specified at terminal backboards.

b. Provide a minimum of 18-inches of slack cable in each workstation outlet box and outlet locations.

c. Provide 10-feet of cable slack in ceiling above each work station outlet.

d. Provide 24-inches of slack in each cable at patch panel locations.

e. Coil and "Velcro" wrap slack cable.

6. Provide “horizontal wiring” cables installed from individual computer/data workstation outlets to respective terminal closet/room patch panel. Cables shall be continuous without cutting or splices.

7. Provide “horizontal wiring” cables installed from individual workstation telephone/voice handset outlets to respective terminal closet/room terminal patch panels. Cables shall be continuous without cutting or splices.

8. Provide “backbone” cables installed between MDF/IDF terminal rooms/closets patch panels. Cables shall be continuous without cutting or splices.

B. Cable Pulling Lubrication

1. Cable pulling lubricants shall be specifically approved by the cable manufacturer. The following lubricants shall be used where approved by the cable manufacturer.

   a. Slip X -300, American Colloid Co.

   b. Bishop #45, Bishop Electric.

   c. MacLube CA51, MacProducts.

   d. Minerallac H2B, Minerallac Electric.

   e. Winter grade #7437-PC, General Machine Products.

   f. Gel-lube 7/5, Cable associates.

   g. Polywater, A, C, G, American Polywater.

2. Lubricants shall be continuously applied as cable enters raceway.

C. Cable Installation:

1. Do not pull conductors until factory test reports have been submitted and reviewed.

2. Minimum bending radius of fiber optic cables shall not be less than the following. Maximum pulling tension shall not exceed the following. In no case shall the manufacturer's recommendations be violated.

Cable Type	Cable Fiber Quantity	Mini. Bend Radius	Maxi. Pulling Tension
Loose Tube	2-84	9 inches	600 pounds
Loose Tube	86-192	10 inches	600 pounds
Tight Buffered	2-12	5 inches	400 pounds
Tight Buffered	14-24	7 inches	600 pounds
Tight Buffered	26-28	11 inches	1100 pounds
Tight Buffered	48-72	12 inches	1200 pounds

3. The minimum bending radius for copper wire cables shall be 10-times the cable outside diameter. The maximum pulling tension and minimum bending radius shall not violate manufacturer's recommendations.

4. Cables installed in manholes and pull boxes on terminal backboards shall be installed on wall mounted cable support racks.

5. Provide a full 360 degree loop of cable around manhole and pull box interiors.

6. The attachment of pulling devices directly to the cables shall be with individual split mesh basket grips. Direct connection for pulling cables to cable fibers and copper wires shall not occur. Securely tape cable ends to prevent moisture or pulling compound from penetrating cable.

7. The attachment of the pulling device to the cable basket grips shall be made through a swivel connector.

8. The Contractor shall ensure that the cables are fed straight into the raceway taking care to avoid short bends, sharp edges and cable "cross-overs".

9. All lashings used for temporary bunching of the individual cables shall be removed before the cables enter the raceway.

10. Cables shall be "pulled through" or pulled from a "center of run pull" without splices or terminations and minimize cable rolling tension. Lead out the cables at all manholes, pullboxes and conduits taking care to feed them in again by hand for the next portion of the cable run.

11. For each cable pull where a cable direction change is required, flexible feed-in tubes, pullout devices, multi-segmented sheaves etc. shall be used to insure proper cable pulling tensions and side wall pressures. Cables shall not be pulled directly around a short right angle bend. Any device or surface the cable comes in contact with when under pull-in tension shall have a minimum radius 50% greater than the final specified minimum installed cable bending radius. The maximum possible size radius sheaves and feed-in tubes, usable in the available working space, shall be provided in all situations, to insure the minimum possible cable side wall pulling pressure. Do not use devices with multi-segment "roller" type sheaves.

12. Cable lengths over 50 feet shall be machine pulled not hand pulled into and through all raceways. Cables shall be pulled in a continuous, smooth operation without jerking or stop-start motion after initiation of pull. Maximum cable pulling speed shall be less than 50 feet per minute. Minimum cable pulling speed shall be greater than 15 feet per minute.

13. Cables shall be pulled straight into or out of the raceway without bends at the raceway entrance or exit. Pull in cable from the end having the sharpest bend (i.e., bend shall be closest to reel). Keep pulling tension to minimum by liberal use of lubricant, hand turning of reel, and slack feeding of cable into duct entrance. Employ not less than one man at reel and one at manhole or pull hole during this operation. Cables shall be pulled directly from cable reels.

14. Cables shall be trained or racked in trenches, vaults, manholes and pull boxes with consideration given for the minimum specified bending radius of the cable and the possibility of cable movements due to load cycling. The cables shall be racked and supported in such a manner that adequate space is allowed for splicing and the cables shall always be fanned out from the duct or conduit so as not to cross other ducts, conduits or cables. To prevent damage from falling objects or personnel entering the manhole the cables shall not pass directly under the manhole opening.

15. Cable shall be supported in manholes, pull boxes and vaults a minimum of 18-inches on center with cable racks. Provide hot dip galvanized, T-slot racks and support arms. Secure cables to racks with porcelain supports for each cable on the racks. Loosely lash cables to racks. Splices shall be directly supported, on racks. Do not install cables more than one feeder on the same rack hook.

16. Cables shall be routed the long way around manhole, pull hole, etc. with not less than a full 360 degree loop around the perimeter walls unless noted otherwise.

17. Existing conductors shall be protected at all times when contract work occurs in the same area, including but not limited to pull boxes, vaults manholes, cable trenches etc. Provide temporary electrical insulating blankets and barriers over existing conductors to reduce the possibility of accidental mechanical damage to existing conductors.

18. Where cable tray is provided, all cables shall be routed and trained on the cable tray. The cables shall enter the cable tray and route along the tray prior to entering any equipment racks or computer works station outlets.

19. A dynamometer to measure pulling tension shall be used on all cable runs in excess 200 feet or with more than 180 degrees in bends. The actual pulling tension value shall be calculated and recorded for each pull.

20. Bends shall not be made in cable splices or terminations.

21. The portions of cables installed without raceways or cable tray supports shall be installed with metal "J-hook" cable supports.

    a. The "J-hooks" shall provide multitiered "J" shaped hooks, with wide flat cable support base (0.5-inch wide minimum) and smooth rounded corners, specifically designed for copper wire and fiber optic infrastructure cable support. As manufactured by Erico Inc.

    b. The individual "J-hook" attachment to the building structure shall be metal, "beam clamp", "hanger rod", clevis hanger styles as applicable for each attachment location.

    c. Install "J-hooks" not more than 48-inches on center along the entire cable length and within 6-inches of each cable change in direction. Locations of "J-Hooks" and tension of cables shall insure between 4-inches and 6-inches of cable sag between adjacent hooks. Secure cables to "J-hooks" with re-enterable cable tie wraps. "J-hook" supported cables, bundle cables together with re-enterable tie wraps not less than 12-inches on center along the entire cable length.

    d. Each J-hook shall not support more than twelve (12) individual cables. Provide multiple "tiered" J-hooks for additional cable quantities at each location.

    e. "Bridle rings" shall NOT be used to support cables.

    f. Cables shall not lay directly on nor attach to ceilings, ceiling hangers, lighting fixtures, air ducts, piping, or equipment.

22. Re-enterable cable tie wraps shall be, "limited-combustible" and air plenum rated, reusable, color-coded. Chemically and mechanically compatible with the respective cables and install locations. Shall allow multiple open-close operations for securing cables.

23. Electronic network cables containing non-dielectric components shall be installed with a minimum separation from other electrical power conductors and equipment as follows:

Equipment Type	Minimum Separation
a. Lighting fixtures	12 inches
b. Electric motors, electric solenoids, electric Heaters	40 inches

c.	Transformers	48 inches
d.	Circuits over 100 volts to ground, in metallic raceways	5 inches
e.	Circuits over 100 volts to ground, in non-metallic raceway or without any raceway	12 inches
f.	Circuits over 100 volts to ground, suspended on overhead pole lines	48 inches

D. Movement, Storage, and Handling of Cable:

1. Reels of cable shall not be dropped from any height, from trucks or other transporting equipment.

2. Lift and move cable reels using following methods:

   a. Crane or boom type equipment-insert shaft (heavy rod or pipe) through reel hubs and lift with slings on shaft, with spreader or yoke to reduce or avoid sling pressure against reel head.

   b. Fork lift type of equipment may be used to move smaller, narrower width reels. Fork tines should be placed so that lift pressure is on reel heads, not on cable, and shall reach all the way across reels so lift is against both reel heads.

   c. Reels may be moved short distances by rolling. Reels shall be rolled in the direction indicated by arrows painted on reel heads. Surfaces over which the reels are to be rolled shall be solid clear of debris, and also clear of protruding stones, humps, etc. which might damage the cable if the reel straddles them.

3. Storage of reels of cable:

   a. Cable ends shall be sealed prior to shipment to prevent moisture entry into cable. Cable ends shall remain sealed at all times including during installation. Where ends seals are removed, reseal cable ends by stripping cable finishes back 2-inches down to insulation. Then apply four (4) layers of an insulating tape criss-cross over the cable end and carry back at least 4-inches onto cable outer finish. Add a containing cover of two (2) layers of vinyl electrical tape completely over the end seal.

   b. Cable reels shall be shipped with factory applied lagging (protective cover) left in place until removal is absolutely necessary. Additional covering such as tarpaulin, plastic sheeting, etc. shall be used if cable is to be stored outdoors.

   c. Store reels of cable on a firm surface, paved, or on planking to prevent settling into soft ground.

   d. Use fencing or other barriers to protect cables and reels against damage by vehicles or other equipment moving about in the storage area.

3.5 CABLE SPLICES

A. General

1. Splice(s) in cables shall occur only in the following locations:

a. Pull boxes or manholes.

b. Terminal backboard, closets or rooms.

c. Equipment racks.

d. Wall mounted interface cabinet.

e. Do not splice cables in conduit, cable tray, raceways or plenums.

2. Polarity and color-coding shall be maintained consistent through splices, terminations, and outlets for the entire electronic network system.

3. Cable splices in outdoor areas, manholes, pull holes shall be water tight, inside universal splice enclosures.

B. Fiber optic cable splices unless specifically indicated otherwise below, fiber optic cable splices between fiber optic cable fibers shall be fusion type splices.

1. Splices between loose tube gel filled fiber optic cable fibers shall be fusion type splices.

2. Splices between indoor/outdoor fiber optic cable fibers shall be fusion types.

3. "Pigtail" splices of tight buffered and indoor/outdoor fiber optic cable fibers to loose tube gel filled cables shall be fusion type splice.

4. Splices between tight buffered fiber optic cable fibers to indoor/outdoor fiber optic cables shall be fusion type splice or mechanical type splice.

5. Splices between tight buffered fiber optic cable fibers shall be mechanical type splice or fusion type splice.

6. "Pigtail" splices of tight buffered fiber optic cable fibers to tight buffered fiber optic cable fibers shall be mechanical type splice or fusion type splice.

7. Fiber optic splices shall be performed to maintain the data transmission rates specified for the entire respective system.

C. Copper Wire Splice

1. Copper wire extending from infrastructure workstation outlets to respective equipment rack patch panel outlets shall not be cut or broken and shall be continuous end to end.

2. Copper wire extending from telephone/voice workstation outlets to respective terminal blocks shall not be cut or broken and shall be continuous end to end.

3. Copper wire splices shall be performed to maintain the data transmission rates specified for the entire respective system.

3.6 CABLE TERMINATIONS

A. General

1. Infrastructure workstation outlets connecting to ports in patch panels shall be grouped together in the patch panel by outlet function, room location and building area location (i.e.

Group #1 Room #120 1st floor; Group #2 Room 200 east wing, etc.). Each group shall be identified with engraved (etched) nameplates indicating grouping identification and individual port numbers.

2. Polarity and color coding of cable connections at splices, terminations and outlets shall be consistently maintained throughout the entire electronic network system.

3. Terminate all cables onto respective outlets connectors, interconnection couplers and terminals. Terminations shall comply with manufacturer's recommendations, ANSI/TIA/EIA-568C related standards, amendments and TSB.

4. Fiber optic cable fiber strands and copper wire cable conductors terminated at outlet locations shall be connected with a strain relief device attached to the cable jacket to prevent cable tension from being transmitted to the termination connectors.

5. Cable terminations shall be performed to maintain the transmission rates specified for respective system.

B. Fiber Optic Terminations

1. Individual fiber-optic fibers shall each be terminated with a fiber optic fiber connector. The connector for each fiber shall be "plugged" into separate fiber-optic fiber interconnection couplers on the rear of each respective outlet.

2. Each fiber optic termination ferrule shall be inspected, after completion of the termination, visually with a fiber optic inspection microscope and an interferometer, to insure fiber “undercut”, “protruding” fiber, over polish and under polish of fiber termination ends does not exist in the finished termination ferrule.

3. Fiber-optic cables terminated between two (2) fiber optic patch panels located in separate equipment racks. The fibers shall be paired together for purposes of identification. Each pair of connectors for fibers shall be "plugged" into separate, physically adjacent fiber optic fiber interconnection couplers at each patch panel. The horizontal/vertical arrangement of paired patch panel fiber couplers shall match at both ends of the fiber cable.

4. Fiber optic cable fiber strands terminated at patch panels shall be installed with a minimum of 540 degrees of each fiber strand looped around the splice tray individual fiber ”training” rings.

5. Fiber optic cable connecting from infrastructure workstation outlet to a fiber optic patch panel.

   a. The connectors for fibers shall be "plugged" into separate, physically adjacent fiber optic fiber interconnection couplers.

   b. The patch panel coupler shall be color coded to identify the polarity of the transmitting and receiving optical fibers.

6. Fiber optic cable connections at workstation outlets.

   a. The connectors for fibers shall be "plugged" into separate physically adjacent fiber-optic fiber interconnection couplers in the outlet.

C. Copper Wire Terminations

1. Where occurs, the shield on metal shielded copper wire shall be terminated and connected to the shield grounding connection at each termination point.

2. Twisted wire pairs shall not be untwisted for a length of more than 0.4-inches at any location and the cable jacket shall not be stripped back not more than 0.5-inches any location including splices and terminations.

3. Unless specifically directed otherwise by the Owner's Representative, Pin assignment for wiring terminations shall comply with ANSI/TIA/EIA-568C type T568B as required for compatibility with the electronic network equipment. The termination type shall be consistent throughout the project contract area.

3.7 EQUIPMENT RACKS

A. General

1. Install, assemble, mount and connect devices and equipment in the respective equipment racks, bolted securely to the rack frame with stainless steel hardware. "Star" style lock washers shall be provided to insure an electrically continuous ground path between the equipment/devices and rack frames.

2. Provide blank metal filler panels to close unused equipment "front" mounting space in equipment racks, manufacturer's standard finish color.

3. Provide a copper wire outlet connector in the respective equipment rack for each remote copper wire infrastructure workstation outlet and copper wire cable shown connected to the respective equipment rack, plus the spare copper wire outlet connectors required in the contract documents. The copper wire outlet connectors in the equipment racks shall be provided in equipment rack mounted copper wire patch panels. In no case shall the quantity of equipment rack mounted copper wire outlet connectors be less than the quantity of cables indicated on the drawings, plus required spaces/spares.

4. Provide fiber optic fiber connectors and fiber optic fiber interconnection couplers in the respective equipment rack for each remote fiber optic infrastructure workstation outlet, and fiber optics cable fiber shown connected to the respective equipment rack, plus the spare fiber optic fiber connectors required in the contract documents. The fiber optic fiber connectors and fiber optic fiber interconnection couplers in the equipment racks shall be provided in equipment rack mounted fiber optic fiber distribution enclosures (RTDE). In no case shall the quantity of equipment rack mounted fiber optic fiber connectors and fiber optic fiber interconnection couplers be less than the quantity of cables indicated on the drawings, plus required spaces/spares.

5. Fiber optics cable fibers specifically shown as non-terminated "splicing-thru" in the equipment rack shall route through fiber optic splice only enclosures (RMSE), mounted in the respective equipment rack.

6. The maximum quantity of cable terminations, in each equipment rack mounted patch panels shall not exceed the following:

   a. 100% copper wire outlet connectors, 672 maximum per 42U rack. 144 maximum in 24-inch high, 240 maximum in 30-inches high and 432 maximum in 48-inches high mini-equipment racks.

   b. 100% fiber optic fiber terminations, 144 maximum per rack [twenty-four (24) maximum in mini-equipment racks].

   c. Combination of copper wire outlet connectors and fiber optic fiber terminations in the same rack; 48 maximum fiber optic fibers plus 144-maximum copper wire outlet

connectors per rack. [18 maximum fiber plus 192 maximum copper wire in 30-inches high and twenty-four (24) maximum fiber plus 488 maximum copper in 48-inches high mini-equipment racks.]

d. In addition to the quantity of patch panel outlets for termination of incoming and outgoing cables, provide not less than an additional 15% of patch panel spare outlets in each equipment rack for future use.

7. Provide additional equipment racks, quantity of racks to ensure the maximum specified quantity of terminations in single rack are not exceeded and the quantity of cable terminations complies with the requirements of the Contract Documents.

8. Terminal racks, equipment locations, patch panels, and cross connects shall be arranged to allow for natural cabling progression, minimize crossing of cables and allow easy access to each system component.

9. Equipment Rack Anchorage:

a. Equipment racks installed on raised "access floor" systems, shall be supported and anchored with bolts that extend into the "structural" floor located below the "access floor".

b. Securely anchor the support arms of swing gate racks to the wall structural support system.

c. Securely anchor fixed support base of the racks to the floor.

d. Mounting method shall support the total rack weight including installed equipment, but in no case less than 500-pounds with a 2.0 times safety factor.

e. Attachments and anchorages shall comply with the requirements for earthquake seismic zone 4.

10. Unless specifically noted, otherwise provide the following equipment rack types:

a. Floor standing equipment racks containing patch panel locations, computer/data network HUBS/switches and computer data network concentrators, shall be Open Frame style 4-post equipment racks.

b. Wall mounted external to dedicated IDF/MDF terminal rooms/closets (i.e. inside individual classrooms), shall be Mini-Equipment racks.

11. Install ground bus, PDU/TVSS, cable management rings, equipment, patch panel and patch panel outlets, etc. in equipment racks.

12. Equipment rack terminology:

a. The location containing the main campus equipment rack location shall be identified as the Main Distribution Frame (MDF).

b. The locations remote from the MDF containing satellite equipment racks shall be identified as Intermediate Distribution Frames (IDF).

c. An individual building located on a multi-building campus site with multiple equipment rack locations in the building, the building main rack location shall be identified as Sub-MDF and the remaining equipment rack locations in the building shall be identified as IDF.

B. Floor Standing Equipment Racks

1. General:

a. Securely anchor racks to floor.

b. All incoming cables shall enter through the top or bottom of the racks.

c. The front of the racks shall maintain a minimum of 42-inches of clear working space.

d. Multiple floor standing racks shall be installed directly adjacent to each other (i.e. side by side), with adjacent vertical rails bolted together.

e. Cables entering racks shall enter into the top of the rack from overhead cable tray or from wall along wall support arms to rack.

2. Floor standing open equipment racks.

a. The rear of the rack shall maintain a minimum of 54-inches clear working space behind the rack frame rails for adequate installation depth of HUBS/switches equipment, for "walk" behind access to equipment and for cable terminations access.

C. Mini-Equipment Racks:

1. Install surface mount on the wall, on wall mount horizontal “C” channels.

2. In public spaces the bottom of the rack shall not be less than 6-feet – 6-inches above finish floor. Top of rack shall be tight to ceiling.

3. Position the rack to allow the door section, and center section to swing open a full 90 degrees Arc without obstructions.

4. Connect raceways to the non-moveable pan section.

3.8 MDF AND IDF CIRCUIT TERMINAL ROOMS AND CLOSETS

A. Terminal Backboard

1. A ¾-inch thick marine "A-C" grade plywood backboard shall fully cover each wall of terminal closets and terminal rooms, including all MDF and IDF rooms/closets. Provide backboard on the wall for equipment racks, incoming cable raceways and terminal blocks. Plywood shall extend continuous from the finish floor to 8-feet above the finish floor on all walls. "A" side of plywood shall be exposed.

2. Attach plywood to wall structural framing with mechanical fasteners a minimum 6-inches on center vertically on walls at each framing vertical member, and along the length of the wall, but not less than 16-inches on center horizontally along the length of the wall.

3. Paint plywood terminal backboards after installation and prior to mounting any equipment. One (1) coat of wood paint fire resistant primer and two (2) coats of fire resistant/intumescent, non-conductive finish coats of paint. Finish color matt/flat white, acrylic enamel fire resistant/ retardant latex paint.

B. Cable Tray

1. Locations with equipment racks, installed in the same room/closet (MDF or IDF).

a. Provide a horizontal cable tray above the equipment racks in each circuit terminal room and closet.

b. Provide a horizontal cable tray continuous “loop” around the perimeter inside each MDF and IDF room, within 12-24 inches above the doorway. Parallel with and adjacent to all walls in the room.

2. Ladder type cable tray 18-inches wide by 6-inches deep; length-end wall to end wall, of the closet or room.

3. Install the cable tray centered above all equipment racks, and around the room perimeter at ceiling/walls with ceiling and wall suspension system. Install trays not more than 36 inches above and not less than 12-inches above the top of the equipment racks.

4. Where multiple segments of cable trays occur in terminal closets and rooms, provide interconnecting cable trays between each segment located in the respective room/closet.

C. Conductor Training and Support

1. Provide conductor/cable training and racking support distribution rings installed on backboards. As manufactured by Newton 3042 series, Saunders or equal.

2. Support rings shall be spaced a minimum of 10-inches on center along all cable/conductor routing paths on backboards and within 4-inches of each change in cable/conductor direction.

3. The capacity of support rings shall be equal to the weight and quantity of conductors/cables passing through the respective support ring plus 100% spare capacity for installation future conductors/cables. In no case shall support rings be smaller than 3-inches.

4. Attach support rings to backboards with not less than two (2) 3/8-inch diameter by 1⅛-inch long threaded wood anchor bolts for each individual bracket.

D. Environment Space Monitoring (MDF and IDF)

1. In each room/closet provide one (1) automatic environmental monitor. Self calibrating, simultaneous monitoring and software programmable, with alarm set points. Shall measure and monitor ambient conditions and provide data-logging for conditions in the space for the following:

a. One (1) ambient temperature port and plug-in indoor sensor.

b. One (1) ambient humidity port and plug-in indoor sensor.

c. One (1) spare plug-in port for an external digital sensor.

2. Digital Fast Ethernet LAN RJ-45 communications port with alarm alerting and communications software for remote monitoring of the ambient conditions via the LAN. Must be compatible with Owner’s existing software monitoring tools.

3. Local internal audio and visual alert annunciators, with local silence and reset.

4. 120 volt, 60Hz AC input power supply operation. Equipment rack mount self contained unit housing configuration. Provide all interconnect cabling and connectors.

5. Provide the environmental unit in one of the equipment racks located in each of the respective spaces.

6. As manufactured by Avtech-Room Alert; or SensaTronic-Evironmental Systems; or IT Watch Dog-Climate Monitors.

3.9 GROUND (ADDITIONAL REQUIREMENTS)

A. Electronic Equipment MDF, IDF and Terminal Rooms and Closets

1. Terminal equipment ground bus (TEGB) - Provide a wall mounted TEGB ground bus in each MDF location. Also provide a TEGB where two or more equipment racks are provided in each IDF. The TEGB ground bus shall be copper ¼-inch by 2-inches (nominal) by 12-inches long (minimum). Install the TEGB on the wall with a minimum of two (2) "stand-off" electrical insulators. Drill and tap the ground bus and provide bolted type ground lugs for connection of each ground conductors size #10AWG - #1AWG. Provide four (4) spare unused ground lugs on the TEGB.

2. Provide 1.25-inch conduit with 1#1AWG copper insulated ground conductor from the TEGB homerun to the building main ground reference bus. Provide 1.25-inch conduit with 1#1AWG copper insulated ground conductor from the TEGB homerun to the nearest building main structural steel member and to the nearest metal cold water pipe larger than 0.6-inch diameter pipe.

   a. Provide the same ground connections from the equipment rack ground bus where only a single equipment rack occurs in the IDF location.

3. The ground conductor required from the TEGB to the building main ground reference bus may be looped and connected between separate TEGB ground bus locations if all of the following conditions are met.

   a. The ground conductor is increased to 1.5-inch conduit with 1#2/0AWG copper insulated and the total end to end length does not exceed 300-feet.

   b. The building exceeds two (2) floors in height.

   c. Not more than four (4) TEGB buses are connected to the same "looped" ground conductor.

   d. The TEGB ground conductor is continuous (not cut, spliced or broken) along its entire length.

   e. The TEGB ground conductor is connected to the TEGB ground buses with a UL listed "Exothermic" welding process.

B. Equipment Racks:

1. Provide a separate #12AWG copper stranded green insulated ground conductor from each individual equipment element in the rack to the respective rack ground bus.

2. Provide a separate #8AWG copper insulated ground conductor from each equipment rack ground bus to the TEGB terminal equipment ground bus located in the same space.

3. Where only one equipment rack is installed, provide 1.25-inch conduit with 1#1AWG copper insulated ground homerun conductor from the equipment rack ground bus homerun to the building main ground reference bus and provide 1.25-inch conduit with 1#1AWG copper insulated ground conductor from the TEGB or single equipment rack ground bus (as applicable), to the nearest building main structural steel member and to the nearest metal cold water pipe larger than 0.6-inch diameter pipe.

4. Provide 1.25-inch conduit with 1#4AWG copper insulated ground conductor from each wall mounted fiber interface cabinet to the respective TEGB ground buses.

5. Provide a 1#10AWG copper insulated ground conductor connecting in a continuous loop to all miscellaneous cable trays and metal support equipment located in the terminal closet or room and connect to the TEGB ground bus.

C. Telephone/Voice Terminal Blocks:

1. Provide a separate #8 copper insulated ground conductor from each terminal block section ground bus to the TEGB terminal equipment ground bus.

2. Provide a separate #6 copper insulted ground conductor from the terminal room/closet to the lightning ground system.

3.10 WALL MOUNTED FIBER INTERFACE CABINET - WMIC

The WMIC shall provide the interface/transition for any loose tube gel filled fiber optic cable entrance into a building for "Pigtail" terminations into equipment located in the building or "thru splices" onto other areas.

3.11 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. General

1. Fiber optic and copper wire cables shall be identified in each manhole, pull box, equipment rack, patch panel and computer workstation outlets.

2. Infrastructure documentation, identification labels and color coding shall comply with ANSI/TIA/EIA-606A Administration Standard for Telecommunications Infrastructures, Class-1 through Class-4. Provide management software MS-Windows-based single user license, with all as-built data entry documentation information complete.

3. Color-Coding of Termination (Specific additional OWNER's requirements): Termination at the MDF/IDF termination areas and at telephone terminals shall be color-coded with colored designation strips. Designation strips will be marked with architectural area designation as indicated on the plans. Colored designation strips shall be assigned as follows:

a.	Data Outlets	Black
b.	Voice Outlets	Red
c.	Multi-pair copper (MDF/IDF)	Green
d.	Multi-pair copper (Voice)	Yellow

B. Identification tags shall include the following information:

1. Cable name as indicated on drawings (i.e., HV1, F4, MSB3 etc.).

2. Installation month and date (i.e., 3/92, 4/78 etc.).

3. Conductor size conductor type (i.e., loose tube fiber; (#24AWG ScTP Category 5, 200 pair, telephone/voice etc.).

4. Feeder taps to equipment or building shall also be identified with equipment name or building (i.e. library, SW1, Rack #21, etc.)

C. Identification Tags

1. Tags shall be ⅛-inch thick 98% lead, approximately 2-inch square with chamfered corners. Two holes shall be drilled for attachment to primary cable. Lettering shall be 0.25-inch high, engraved or die stamped. Attach tags to primary cables with two #14AWG (THWN insulated) solid copper conductors "twist-tied", with insulated CAP wire-nut on the tie-wire ends, to cover sharp edges of tie-wire conductor.

2. Alternate identification tags, at the CONTRACTOR'S option in lieu of lead tags. Provide polypropylene tag holders with interchangeable, yellow polypropylene tag with black alphanumeric character sets. Characters shall be approximately 0.25-inch high. As manufactured by Almetek industries "EZTAG" Ledgewood, New Jersey.

D. Equipment and outlet naming identification and color-coding shall comply with ANSI/EIA/TIA latest revision.

1. Naming method for equipment, outlets and cables; where a position in the naming string is unused, provide multiple "****" symbols.

Typical naming string "ADM-02-1141-PP17-1271"

a. "ADM" - Abbreviated Building Name or Number (i.e., Administration, B127, etc.)

b. "02" - Floor Level #2 or as applicable.

c. "1141" - Outlet, Equipment or Terminal Room/Closet name or room number as applicable.

d. "PP17" - Terminal Rack Patch Panel Identification.

e. "1271" - Individual Outlet or Port Identification.

2. Connecting hardware color coding shall be as follows:

"Green" - Main central terminal location for entire site.

"White" - Distributed terminal locations other than the main terminal.

"Blue" - Horizontal wiring hardware systems for workstations.

E. Documentation and Labeling (Specific additional OWNER’s requirements)

1. The Contractor shall provide printed labels for all cables and cords, distribution frames and outlet locations. No labels are to be written by hand.

2. An example of appropriate classroom/end user outlet documentation/labeling shall be as follows:

- Label on room outlet jack = D85/1311
- Type outlet:
  - D = Data only including VOIP
  - V = Voice only
  - 85 (numeric jack assignment on MDF, IDF or telephone terminal)
  - 1311 (MDF or IDF room number)

3. An example of appropriate patch panel/punch block documentation/labeling shall be as follows:

- Label on patch panel = 85/1306
- Type outlet:
  - 85 (numeric jack assignment on MDF, IDF or telephone terminal)
  - 1306 (room number)
  - When multiple patch panels are installed at the MDF/IDF, port numbering should be continuous (i.e. the second patch panel should begin with port #49, not #1)

4. An example of appropriate inter-building cabling documentation/labeling shall be as follows:

- Outlet label on LIU (MDF and IDF)
  - MDF LIU: 4742 (IDF room number)
  - IDF LIU: 1103 (MDF room number)

F. Provide warning nameplates on fiber optic patch panels, fiber optic outlets, and any location where fiber optic cables are terminated. Minimum 0.25-inch high engraved/etched letters. "WARNING - LASER LIGHT SOURCE. DO NOT LOOK DIRECTLY AT OUTLET OR FIBER CABLE ENDS. RISK OF SEVERE EYE DAMAGE OR BLINDNESS".

3.12 TRUNKING CABLE TERMINAL BLOCKS

A. The trunking cable terminal blocks shall be assembled in vertical sections, for wall mounting. Install adjacent vertical sections with not less than 8-inches blank space between sections, for cable training space.

B. Install terminal blocks on plywood terminal backboard with #8 x 1-inch wood screws. Minimum 6 inches on center, along each side of each terminal block.

C. Terminal block wire pair capacity:

1. The minimum wire termination capacity shall not be less than 300-pairs of trunking cable conductors, at each terminal block assembly.

2. Plus fifteen (15) spare capacity.

D. Trunking cable installation:

1. Trunking cable and insulation shall be rated for installation in the locations shown on the drawing, installed in conduit end-to-end.

a. Outdoor underground or exposed to sun, wet locations installed in conduit.

b. Inside the building installed in conduit

END OF SECTION

SECTION 27 51 13

PAGING SYSTEM

PART1 GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances tools, equipment, facilities transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other sections for work related to those other sections and required to be included as work under this section.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit product data sheets and descriptive literature for all component parts.

B. Submit block wiring diagram of the clock and paging systems. Showing headend equipment, terminal cabinets, remote power supplies, and typical clock and speaker for each zone.

1.03 EQUIPMENT QUALIFICATION

A. The specification is based on the equipment of manufacturers who have been approved by the District and the manufacturers herein named shall be considered as meeting the requirements of this specification. For all items which are identified by part number and manufacturer the Performance specifications which are published in the most recent manufacturer's data sheets available at the time of bidding this project shall be applicable to the present work as though fully written out herein.

B. All equipment shall conform to all local applicable codes and ordinances, and shall be listed by Underwriters Laboratories.

C. System shall be Bogen Multicom Current compatible series to integrate with existing maintenance and operations standards on the Campus. No substitutions will be approved.

1.04 QUALIFICATIONS

A. To qualify as an acceptable bidder, whether the bid is submitted to the District, his agent, a general contractor or a sub-contractor, the system bidder or contractor shall be qualified sound contractor and shall hold a valid C61 License issued by the Contractors State License Board of California. The system bidder or Contractor shall hereinafter be referred to as the Contractor. The Contractor shall hold all other licenses required by the legally constituted authorities having jurisdiction over the work. The Contractor shall be the factory authorized distributor for the brand of equipment offered and shall have been engaged in the business of supplying and installing the specified type of system for at least five years. The Contractor shall maintain a fully equipped service organization capable of. furnishing adequate repair service to the equipment.

PART 2 PRODUCTS

2.01 MATERIALS

Comply with pertinent provisions of Section 26 05 00.

2.02 GENERAL

A. Eight separate paging zones, each of which may be programmed in software to belong to any combination of zones plus all-call. Initially zones shall be provided and programmed as follows:
   1. One zone for each interior speaker.
   2. One zone for outside speakers by building.
   3. One zone for outside speakers located toward ballfields.
   4. One zone for each of the five academies.

B. The System shall be equipped with one (1) program channel for distribution to any speaker or group of speakers on the system.

C. System shall include inputs for connection of the telephone system so paging can be initiated from telephones.

D. System shall include a separate desk type telephone and desk mounted microphone at receptionist desk for paging and announcements.

E. Head-end equipment shall be housed in a rack constructed of at least 16 ga. heavily steel, heavily reinforced for maximum strength and durability. The rack shall be finished in Baked Enamel and have a hinged and key-locking rear doors for easy access to the equipment by authorized personnel.

F. Within the rack shall be an AM/FM tuner, cassette tape player, and a compact disc player.

G. Within the rack shall be a tone generator capable of supplying four separate distinct alarm tones, plus a separate chime signal. The selection of the tones will be software programmable to sound over the systems speakers.

H. Provide a solid state microprocessor-controlled master clock interfaced with the system to sound class-passing signals. Master clock shall have the following minimum features:
   1. Capable of storing up to 350 events plus 100 holidays.
   2. Automatic Daylight Savings Change.
   3. Programmable 8 separate zones.
   4. Each schedule shall have the choice of sounding class-passing signals.
   5. Resets slave clocks automatically after power failure.
   6. Five-year battery back-up shall be provided for time keeping.
   7. Key switch to prevent tampering.
   8. Software selection of user zones.
   9. Capable of operating and correcting both direct read digital and analog synchronous clocks.
   10. Relay outputs.
   11. Output test circuit.
   12. Class-pass time duration shall initially be software programmed as follows:
      a. Interior circuits- 5 seconds.
      b. Exterior circuits - 15 seconds.

I. Power amplifiers shall be UL listed, with the following features:
   1. Each amplifier shall have than 1% harmonic distortion at its full rated output. Hum and noise level shall be greater than 105dB (A- weighted) below rated output. Frequency response shall be +1dB, 20-20,000 Hz.
   2. Input impedance shall be 20,000 ohms nominal balanced. Controls shall be provided for level control setting. Each amplifier shall be capable of delivering full rated output to 25V or 70.7V constant voltage lines.
   3. Exterior building-mounted speakers shall be driven by amplifier(s) separate from the interior speakers. Quantity and output rating of amplifiers driving exterior speakers shall be based on each speaker tapped at 3 watts. Provide spare amplifier capacity for the future addition of 25% additional exterior speakers.

4. Quantity and output rating of amplifiers driving indoor speakers shall be based on each speaker tapped at 1/2 watt. Provide spare amplifier capacity for the future addition of 25% additional interior speakers.

2.03 CABLING

A. Cable run in conduits below grade shall be approved by the manufacturer for the purpose.

B. Cable serving speakers shall be a twisted pair of #16 AWG solid copper conductors with overall jacket.

C. Provide multiple pairs of 70.7 volt conductors for paging circuits from headend amplifiers to each building to match system zoning requirements.

2.04 SPEAKERS AND ACCESSORIES

A. Interior speakers shall be 8-inch diameter paper cone type with line matching transformer. Frequency range to be 30 to 15,000 Hz. Interior wall-mounted speakers shall be flush mounted in Soundolier #198-8 backbox and metallic screw-on grille.

B. Exterior speaker assembly shall consist of an Atlas #APF-15 series loudspeaker with T-11 transformer in a Soundolier #L20-211NP161-APF backbox and cover or equal. Housing shall include a baffle and shall be painted to match surrounding surfaces.

C. Provide power supplies in the system terminal cabinets throughout the project as required to properly operate all speakers indicated.

PART 3 EXECUTION

3.01 MATERIALS

Comply with pertinent provisions of Section 26 05 00

3.02 WIRING DESIGNATION AND TERMINAL CABINET MAKE UP

A. All connections throughout the system shall be made on barrier screw terminals. All conductors in terminal cabinets shall be carefully formed and harnessed in a workmanlike manner.

3.03 INTERFACE

A. Provide connection between fire alarm control panel and class-passing equipment and between fire alarm control panel and paging system equipment. In the event of fire alarm alert, the fire alarm shall override the class-passing and paging systems.

3.04 PROGRAMMING

A. All programming shall be as directed by the District.

3.05 The Contractor shall provide four (4) copies of the complete as-built drawings and service manuals. The drawings and manuals shall include the following:

1. Identification of all components and cable runs in the system. The identification numbers must match those used in construction.
2. Service manuals and schematic diagrams of all active components used in the system.
3. A complete manual must be assembled and organized to permit easy reference and cross-checking and to facilitate future servicing.
4. A complete block diagram.
5. All information shall be printed or typewritten.

3.06 Provide a minimum of two (2), four hour periods to instruct district personnel in proper operation of all systems. The first instructional period shall be held and electronically recorded audio/visually prior to final acceptance of the systems and a DVD of the training turned over to the Director of FASO. The second instructional period shall be within a period of one year after final acceptance of the systems, held at the site during normal working hours, Mon-Fri, upon request of the District, and arranged a minimum of 7 working days in advance.

END OF SECTION

SECTION 28 16 00

INTRUSION DETECTION SYSTEM

PART1 GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other specifications sections and drawings for related work required to be included as work under Division 26 00 00, 27 00 00, 28 00 00.
   2. General provisions and requirements for electrical work.

1.02 QUALIFICATION OF BIDDERS AND EQUIPMENT

A. To qualify as an acceptable bidder, whether the bid is submitted to the District, his agent, a general contractor or a sub-contractor, the system bidder or contractor shall be qualified contractor and shall hold a valid License issued by the State of California Department of Consumer Affairs Collection and Investigation Services for the purpose of installing security systems. The system bidder or Contractor shall hereinafter be referred to as the Contractor. The Contractor shall hold all other licenses required by the legally constituted authorities having jurisdiction over the work. The Contractor shall be the factory authorized distributor for the branch of equipment offered and shall have been engaged in the business of supplying and installing the specified type of system for at least five years. The Contractor shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment. The Contractor shall be financially able to provide a performance bond covering the work and the guarantee described.· The Contractor shall provide that bond if requested.

B. The existing security system equipment is made by Hirsch, all new devices shall be connected to this system and the system shall be re-programmed as necessary for proper operation..

C. The system shall be serviced by a field supported 2-year warranty.

D. The specification is based on the equipment of manufacturers who have been approved by the District and the manufacturers herein named shall be considered as meeting the requirements of this specification. For all items which are identified by part number and manufacturer the Performance specifications which are published in the most recent manufacturers data sheets available at the time of bidding this project shall be applicable to the present work as though fully written out herein.

E. All equipment shall conform to all local applicable codes and ordinances, and shall be listed by Underwriters Laboratories.

F. Installation Certification
   1. Work and material for cables, cable terminations and related components shall be performed by certified installers. The installer shall be certified by the respective product manufacturers.
   2. The manufacturers of the indicated work and material, shall provide a installer education/training and certification program for the supplied products.
   3. The installers performing the Contract work for the indicated products, shall have attended and successfully completed each of the respective manufacturer's installation training education programs for the specified products.
   4. Submit six (6) copies of the manufacturer's certifications for each installer performing the work. The submittal shall be approved prior to initiating any related contract work.

5. Contract material installed and work performed by installers not complying with these requirements shall be removed. Removal of work and material not in compliance with these requirements shall done at the CONTRACTOR'S expense, without any additional cost to the contract and without any additional contract completion due date extensions. New material and work required to replace the non-compiling removed work and material shall be provided at the CONTRACTOR'S expense, without any additional cost to the contract and without any additional contract completion due date extensions.

1.03 PERFORMANCE REQUIREMENTS

A. Provide main control panel, terminal cabinets, keypads, and site underground conduits as indicated.

B. Provide motion sensor(s) in each room having exterior doors, exterior glass, or skylights. Quantity of sensors in each room shall be as required to detect entry through exterior doors, exterior glass, or skylights.

C. Provide a magnetic switch at the entry door to each building, near its respective keypad. Connect to the system to initiate a timing circuit for keypad operation.

D. Provide magnetic switches at roof hatches.

E. Provide all conduits, cabling, and outlet boxes required for a complete and operable system.

F. Meet with representatives of the District at a time and location convenient to the District. Advise the District of programming options and incorporate all requirements onto the shop drawings before submittal to the Architect.

1.04 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit evidence of having met with District representatives as specified herein.

B. Submit product data sheets for all switches, keypads, wiring devices, device plates, controllers, power supplies, cabinets, etc.

C. Submit detailed shop diagrams including dimensioned plans, elevations, details, schematic and point-to-point wiring diagrams and descriptive literature for all component parts and cabinets.

D. Submit six (6) copies redrawn building floor plans showing all components of the intrusion detection system including interconnecting cabling and conduits. Sensors shall be located on the drawings in the location conforming to the requirements stated herein. Drawings shall be prepared to scale and show all exterior glass, exterior doors, all interior and exterior building walls, roof hatches, architectural and structural elements relevant to the installation of the system. Each zone shall be shown on the plans.

PART 2 PRODUCTS

2.01 SYSTEM FUNCTIONS

A. Provide a complete and operable supervised intrusion detection system as shown on the plans including but not limited to master control panel, key pad stations, motion detectors, connections to door switches, a State Fire Marshal listed digital communicator, and an automatic dialer.

B. Upon detection of an intruder by initiation of any device in the system, the system shall cause the annunciator LED to light and sound an alarm signal on the school's telecommunication system. Alarm information shall be sent by digital dialer to central station alarm monitoring agency.

C. Systems shall detect the motion of a body taking not more than four steps in an area secured with motion detection equipment where entry doors or windows are possible access.

D. Each building area shall be on a separate zone with each zone controlled separately so that any building area may be secured while others remain unsecured.

E. The system shall be capable of off-site computerized access for remote access, programming and control.

2.02 CONTROL PANEL

A. Control/Communicator panel is be a Hirsch Security System control panel compatible with an integral digital communicator and shall be Underwriters Laboratories listed. All external circuit connections shall be UL listed as power limited in accordance with the provisions of Article 760 of the California Electrical Code (CEC).
   1. Provide point of protection (POPEX) modules at the control panel for Popit module supervision.
   2. Provide point of protection identification transponders (Popit) modules at building terminal cabinets to individually identify each detector in the system.

B. The control/communicator shall be IP based.

C. System shall include the following features:
   1. Real time clock and test timer.
   2. Battery charging circuit.
   3. Battery voltage supervision.
   4. Supervised automatic reset circuit breakers.
   5. Onboard warning buzzer and diagnostic LEOs.
   6. Automatic answer modem.
   7. Lightning and RFI protection.
   8. Central Station reporting format.
   9. Printer/CRT interface module for on-site serial data printer recording or CRT display of events.
   10. Quad serial output module for enhanced serial data interface capability for specific accessory modules and devices.
   11. Individual zone responses.
   12. Custom annunciator text.
   13. Audible alarm output, steady or pulsed.
   14. Automatic silencing.
   15. Attack-Resistant enclosure and lock meeting Underwriters Laboratory Local Burglary requirements.
   16. A minimum of eight (8) auxiliary form "C" dry contacts for a variety of programmable responses to alarm and trouble conditions.
   17. Transformer enclosure for internal mounting of Class 2 transformer.
   18. Two telephone numbers with selective signaling options.
   19. Individual zone responses.
   20. Automatic test reports.

2.03 Bar-code programmer for diagnostics and programming capability.

2.04 RECEIVER

A. Receiver shall be Bosch Security System #D6600 Series, UL listed for fire and intrusion detection.

B. Provide a 50VA Class 2 plug in transformer for power input.

C. System shall contain 48 hours of standby power utilizing rechargeable sealed lead acid batteries and a battery charger.

D. System shall be FCC approved for telephone connections.

E. An alpha numeric LCD display shall indicate account number, area number, time, date, event, zone or point number, line or group number, status and external devices.

F. 24-hour clock and 128 year calendar.

G. 40 character line internal printer and interface capability with an external serial printer.

H. Transmission verification appropriate with the format utilized.

I. Storage of 249 separate events.

J. Transmission format shall support the control panel.

K. Turn the receiver over to the District for central station or campus monitoring.

2.05 REMOTE ACCOUNT MANAGER

A. System shall be Bosch Security Systems #D5300 series or equal with all equipment necessary for computerized access, programming, diagnostics, and remote control of the system. It shall be possible to remotely change passcodes, locate faults, shunt problem zones, arm and disarm the system, silence alarms, and control the auxiliary output contacts in the control panel.

B. System shall permit remote diagnostics including utility and battery power conditions, phone line condition, event memory by zone, and current clock and calendar settings.

C. System shall be 100% IBM compatible for use with personal computers.

D. System shall include a plug-in modem and software necessary for a complete and operable installation. Furnish the District with a software license agreement for updated software enhancements as they develop.

2.06 KEYPADS

A. Master keypad shall be Bosch Security Systems #D1260 Alpha V Command Center series or equal capable of displaying system status and controlling the alarm system. Unit shall receive its operating power from the main control panel. Keypad shall be flush-mounted on a wall near the entry doors of each Building. Faceplate shall be brass or stainless steel as selected by the Architect.

B. Sub-zone keypads shall be Bosch Security Systems #D720 series or equal to allow individual zones to be bypassed. Keypad shall be flush wall where shown on plans Faceplate shall be brass or stainless steel as selected by the Architect.

2.07 Motion sensors shall be Detection Systems Inc. DS774i; Series for wall-mounted types and DS938Z for ceiling mounted types. Sensors shall be dual performance, dual event devices to minimize false alarms or equal passive infrared devices detecting thermal motion signals. Sensor coverage patterns shall be as required for optimum coverage at each individual location. Sensor shall be adjustable Gimbal mounted with plate and outlet box. Provide an attack resistant enclosure DS AE774 at Multipurpose areas.

2.08 Magnetic switch shall be fully concealed in the door frame, Admeco, Sentrol or equal.

2.09 Each intrusion detection system terminal cabinet shall contain a power supply for motion sensors and/or POPIT/POPEX (Zonex) modules.

2.10 Cabling shall be as required for system operation. All cabling shall be shielded.

PART 3 EXECUTION

3.01 All connections throughout the system shall be soldered, crimped by means of AMP lugs, fastened with screw type terminals, made by spring tension clip "punch block" terminals or make by standard plugs and receptacles. Each wire twisted pair or cable shall be tagged throughout the site with EZ Markers with the room number it serves. All conductors in terminal cabinets shall be carefully formed and harnessed in a workmanlike manner.

3.02 All system cabling shall be installed in conduit except where wiring occurs above accessible ceilings. Wiring not in conduit shall be UL listed plenum-type cable. All wiring in walls shall be in conduit. All conduits shall be run concealed. Where architecture precludes concealed conduits, run conduits on top of beams or trusses and minimize the exposure to view. Identify on the submittal drawings all locations where conduits must run exposed.

3.03 Locate motion sensors to provide optimum coverage of the space and to avoid conflicts with the architectural aesthetics of the building. Submittal drawings shall show the exact locations of all system sensors and keypads for approval by District's maintenance managers.

3.04 Coordinate concealed door switch installations with finish hardware manufacturer.

3.05 Provide all system programming as required by the District's Electronic Tech's Regional Maintenance Supervisor, including the necessary product handlers, so that all parameters are entered into the system and the annunciator displays a text, which is customized to the facility.

3.06 SYSTEM TESTING AND DOCUMENTATION

A. Before the contract shall be considered complete, the Contractor shall program the system per District requirements and demonstrate the performance of the system in the presence of the District. The Contractor shall provide all test and reception gear required to prove the performance as outlined.

B. Actuate motion sensing devices and verify that the system performs as specified.

C. The communication loops shall be opened in at least two (2) locations per building to check for the presence of correct supervisory circuitry.

D. When the testing has been completed to the satisfaction of both contractor's job foreman and the representatives of the manufacturer and the DSA inspector, a notarized letter co-signed by each attesting to the satisfactory completion of said testing shall be provided by the contractor and forwarded to the Architect.

3.07 Provide a minimum of two (2), four hour periods to instruct District personnel in proper operation of all systems. Instruction to be arranged in advance at the District's convenience and conducted during normal working hours from 6:30 a.m. to 3:00 p.m. Monday through Friday. Instructors and participants shall sign an attendance sheet of which a copy is to be given to the district Authorized Representative during closeout documentation. The first instructional period shall be held prior to final acceptance of the systems. Instructional training shall be done at the project site and shall be conducted by factory-trained technical personnel. Furnish the District with an electronic audio/visual recording of the first instruction session on a DVD. The second instructional period shall be within a period of one year after final acceptance of the systems, upon request of the District, during normal working hours 6:30 a.m. to 3:00 p.m., Monday through Friday.

END OF SECTION

SECTION 28 31 00
FIRE ALARM

PART 1 GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other specifications sections and drawings for related work required to be included as work under Division 26 00 00, 27 00 00, 28 00 00.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit eight (8) copies of the following to the Architect for approval.
   1. A listing of all fire alarm components and equipment including the California State Fire Marshal (CSFM) listing numbers.
   2. CSFM listing sheets of all devices being used.
   3. Manufacturers' standard catalog data for fire alarm components.
      a. The submittal shall be arranged in the order of the Specification and shall list the specification paragraph number, the name, the proposed model and manufacturer for each item as well as a reference indicating the specific piece of data which can be easily located in the brochure.
      b. The manufacturers' data sheets shall be marked to indicate the specific item being proposed in cases where the sheet covers several types or sizes of item. The data sheet shall completely describe the proposed item.
      c. Where modification to the equipment is necessary to meet the operational requirements of the contract documents and the data sheets shall include complete mechanical and electrical shop drawings detailing the modification.
   4. A listing of the outlet rough-in needed for every device and equipment item. The applicable symbol which illustrates that rough-in item on the job plans shall be drawn on the proposal, opposite the description of the rough-in to facilitate locating the data by field personnel.
   5. Elevation and dimensional information.

1.03 APPLICABLE STANDARDS

A. The equipment shall be listed, labeled, and approved for the application shown in contract documents, as fire alarm equipment complying with the following requirements:
   1. List of applicable codes as of November 1, 2002:
      a. 2010 Building Standards Administrative Code, Part 1, Title 24 C.C.R.
      b. 2010 California Building Code (CBC), Part 2, Title 24 C.C.R.
      c. 2010 California Electrical Code (CEC), Part 3, Title 24 C.C.R.
      d. 2010 California Mechanical Code (CMC), Part 4, Title 24 C.C.R.
      e. 2010 California Plumbing Code (CPC), Part 5, Title 24 C.C.R.
      f. 2010 California Fire Code (CFC), Part 9, Title 24, C.C.R.
      g. 2010 California Referenced Standards Code, Part 12, Title 24, C.C.R.
      h. Title 19, C.C.R., Public Safety, State Fire Marshal Regulations.
      i. 2010 California Energy Code (CEC, Part 6, Title 24 C.C.R.
   2. NFPA Standards and Guides:
      a. NFPA 13, Automatic Sprinkler Systems, 2002 Edition.
      b. NFPA 14, Standpipes Systems, 2007 Edition.
      c. NFPA 14, Dry Chemical Extinguishing Systems, 2002 Edition.
      d. NFPA 17A, Wet Chemical Systems, 2002 Edition.

e. NFPA 24, Private Fire Mains, (included in 1999 NFPA 13) 2007 Edition. f. NFPA 72, National Fire Alarm Code, (California Amended) 2007 Edition.
g. NFPA 253 Critical Radiant Flux of Floor Covering Systems, 2006 Edition.
h. NFPA 2001, Clean Agent Fire Extinguishing Systems, 2004 Edition.

3. The fire alarm system shall conform to the applicable Standards and Guides referenced in CBC Chapter 60.

B. Written certification by the fire alarm equipment manufacturer shall be submitted to the Architect, stating that the system and its component parts are listed and approved by the California State Fire Marshal and the installation has been tested, is operational and conforms to the requirements as set forth in Part 3, Article 24, Title 19, California Code of Regulations.

1.04 EQUIPMENT AND INSTALLING QUALIFICATIONS

A. The equipment shall be manufactured by Notifier to match existing.

B. The specification is based on the equipment of manufacturers who have been approved by the District and the manufacturers herein named shall be considered as meeting the requirements of this specification. For all items which are identified by part number and manufacturer the Performance specifications which are published in the most recent manufacturer's data sheets available at the time of bidding this project shall be applicable to the present work as though fully written out herein.

C. All equipment shall conform to all local applicable codes and ordinances, and shall be listed by Underwriters Laboratories.

D. To qualify as an acceptable bidder, whether the bid is submitted to the District, his agent, a general contractor or a sub-contractor, the system bidder or contractor shall be qualified fire alarm contractor and shall hold a valid C10 License issued by the Contractors State License Board of California. The system bidder or Contractor shall hereinafter be referred to as the Contractor. The Contractor shall hold all other licenses required by the legally constituted authorities having jurisdiction over the work. The Contractor shall be the factory authorized distributor for the branch of equipment offered and shall have been engaged in the business of supplying and installing the specified type of system for at least 5-years. The Contractor shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment. The Contractor shall be financially able to provide a performance bond covering the work and the guarantee described. The Contractor shall provide that bond if requested.

E. Installation Certification

1. Work and material for cables, cable terminations and related components shall be performed by certified installers. The installer shall be certified by the respective product manufacturers.
2. The manufacturers of the indicated work and material, shall provide an installer education /training and certification program for the supplied products.
3. The installers performing the Contract work for the indicated products, shall have attended and successfully completed each of the respective manufacturer's installation training education programs for the specified products.
4. Submit six (6) copies of the manufacturer's certifications for each installer performing the work. The submittal shall be approved prior to initiating any related contract work.
5. Contract material installed and work performed by installers not complying with these requirements shall be removed. Removal of work and material not in compliance with these requirements shall done at the CONTRACTORS' expense, without any additional cost to the contract and without any additional contract completion due date extensions. New material and work required to replace the non-compiling removed work and material shall be provided at the CONTRACTORS' expense, without any additional cost to the contract and without any additional contract completion due date extensions.

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PART 2 PRODUCTS

2.01 GENERAL SYSTEM OPERATION

A. System shall be microprocessor-based, addressable, and power-limited with Class B supervised circuits.
   1. The microprocessor shall execute all supervisory and control programming to detect, report the failure or disconnection of any system module or peripheral device and initiate programmed control sequences. An isolated supervision "watchdog" circuit shall monitor the microprocessor and, upon failure, shall activate the system trouble circuits.
   2. The automatic fire detection and alarm system shall consist of main control panel, transponder panel(s), notification alarm devices, remote annunciator, automatic detection devices, manual stations, printer, and CRT/keyboard, installed and wired in accordance with the drawings and shall function as specified herein.
   3. The system shall be programmable in the field, by a non-computer trained person. All programmed information shall be stored in non-volatile memory.
   4. The system shall operate both addressable and non-addressable ionization, thermal and photoelectric detecting devices, manual stations, water-flow switches, and external control modules.
   5. The control panel shall provide power, annunciation, supervision and control for the fire detection and alarm system. The system shall be designed such that alarm indications override trouble and control conditions.
   6. External circuit supervision shall not require additional wires other than the pair used for detection or alarm (only two (2) wires shall be used from the control panel to each loop of initiating devices and two (2) wires for the notification alarm devices). These two (2) wires shall provide both supervision and notification alarm signals. There shall be no loss of supervision for Class "B" wired addressable devices. Class "A" supervision may be provided by adding an additional pair of wires.

B. Alarm Conditions
   1. Actuation of any manual or automatic alarm initiating device, connected to the system shall cause the following automatic functions.
      a. All notification alarm signaling units shall activate continuously. Audible notification alarms shall sound the California State coded signal.
      b. The respective zone alarm lamp or annunciator alphanumeric readout on the central control panel, and remote annunciator panel, shall be activated.
      c. Activate the Digital Alarm Communicator system.
   2. Actuation of HV/AC air duct smoke detectors shall stop the designated fans and motors in the building's air distribution system.
   3. Actuation of smoke detectors on either side of smoke doors shall energize the release mechanism on the smoke door causing the door to close.
   4. Notification alarm signal duration shall be capable of continuous sounding or adjustable from three to ten minutes.
   5. Perform any additional functions as specified herein or shown on the drawings.

C. Trouble Condition
   1. A single open or single trouble condition in a manual or automatic fire initiating wiring circuit shall activate the respective zone trouble lamp or annunciator readout on the fire alarm control panel and sound a trouble signal at the control panel.
   2. A single open or single trouble condition in the notification alarm signaling wiring circuit shall activate the trouble lamp or annunciator readout in the control panel and sound a trouble signal at the control panel.
   3. 120 volt AC normal power shall be monitored with indication by a "power on" lamp. Upon normal power outage, the system shall activate power trouble condition lamp or annunciator readout, and indicate a trouble condition.

4. The control panel shall monitor the standby batteries and, upon a low battery condition, activate the low battery lamp or annunciator readout and indicate a trouble condition.
5. System ground detection shall be provided for the entire system. Upon ground detection, activate the ground detection lamp or annunciator readout and indicate a trouble condition.

D. Control panels employing alpha numeric readouts shall display the trouble condition along with a prompt to review the list chronologically. The end of the list shall be indicated.

2.02 FIRE ALARM CONTROL PANEL

A. General
1. The fire alarm control panel shall be software programmable, microprocessor controlled, solid state, electronic integrated system. The panel shall be the product of one manufacturer. The control panel shall provide power, annunciation, supervision and control for the detection and alarm system. The detection system shall remain 100% operational, responding to an alarm condition while in the routine maintenance mode.
2. Addressable detection and control devices shall be individually identified by the system, and any quantity of addressable detection devices shall be in alarm and any quantity of addressable control units shall be operable at any time up to the total number connected to the system.
3. The microprocessor shall access the system program, which is stored in non-volatile programmable memory, for all control-by-event (CBE) functions. The system program shall not be lost upon failure of both primary and secondary power. Volatile memory shall not be acceptable.
4. A means shall be provided for acknowledging each abnormal condition. Each activation of the appropriate acknowledge button shall sequentially acknowledge every point in the system. After all the points have been acknowledged, the LEDs shall glow steady and the panel audible signal will be silenced. The total number of alarms, supervisory, and trouble conditions shall be displayed along with a prompt to review each list chronologically. The end of the list shall be so indicated.
5. An alpha numeric annunciator readout shall indicate on the control panel the activation by type, loop, and address of the specific device, sub-loop or alarm/monitor/control point via an alphanumeric display. An audible alert shall sound at the control panel and an alarm light shall flash.
6. If the microprocessor fails, the system shall executive a default signaling program. This program shall enable the control panel to sound the audible signals and summon the Fire Department. In addition, a red LED shall light to indicate the communication loop wherein the alarm originated. Inability of the system to sound signals or summon the fire department during microprocessor failure shall not be acceptable.
7. Protected access to the system controls shall be provided to allow the user/operator access to the following system functions:
   a. Status of all addressable points.
   b. Status of all events logged.
   c. Set/change the real-time clock and date.
   d. Perform an operational manual test of the system from the control panel, including actuation of any initiating device and trouble circuit without alarming the remote central station. The panel shall automatically return to normal mode in the event the panel remains unattended in the service mode.
   e. Retrieve from event log the last 300 alarms, or control points and 300 trouble conditions.
8. Individual input (monitor) and output (control) device addressability shall all be performed on the same pair of wires. Wiring shall be Class "A" or "B". When Class "B" wiring is used, no special wiring sequence shall be required on addressable device circuits. An unlimited number of wiring branches shall be permitted with no loss of supervision.
9. A minimum of 25% addressable monitor, trouble and control points shall be provided.

B. Cabinet
   1. A metal tamper resistant cabinet shall contain the control panel components. Panel shall be surface or flush mounting as indicated on the drawings. Provide a full height tamper resistant hinged locking cabinet door. The door shall have transparent, high impact windows to allow visual observation of all indicators and switches without opening the panel door.
   2. "In-out" circuit conductors shall terminate on numbered screw-type terminals.
   3. All groups of circuits or common equipment shall be clearly marked and shall be expandable by inserting interchangeable units.

C. The control panel shall provide positive protection against the fire alarm system inadvertently being left in a non-operating status. The alarm system shall automatically restore and resound alarms and trouble signals, if subsequent alarm initiating or trouble signals are received under any of the following conditions:
   1. After the alarm or trouble silence switch have been activated.
   2. Prior to resetting system after previous alarm or trouble conditions.

D. The system indicating and operational control devices shall be mounted on the control panel face behind the panel door and shall provide the following minimum functions:
   1. Individual visual indicating pilot lights annunciator or alphanumeric readout to monitor the following alarm system conditions:
      a. Input power.
      b. System common alarm.
      c. System common trouble.
      d. Alarm or trouble signal silenced.
      e. Ground fault.
      f. Battery condition.
      g. Each individual alarm, control or initiating zone-activation.
      h. Each individual alarm, control or notification zone-trouble.
      i. Report, by specific device number, any device removed from an addressable initiating circuit, all other devices shall continue to function.
   2. Manual control switches to allow the following system controls:
      a. Alarm silence.
      b. Trouble silence.
      c. Test all indicating pilot lights and readouts.
      d. System reset, including remote devices connected to the alarm panel.
      e. Alarm test to initiate an alarm condition from the control panel.
      f. Alarm disconnect for system testing without activating the Digital Alarm Communicator system.
      g. Changing the status of configured circuits (arming or disarming and changing status of relays). If any change in status degrades system operation as configured, a trouble condition shall be reported and remain until system operation again meets configured status.
      h. Perform multiple operations at the same time. These operations shall include but not be limited to timed functions and multiple configured sequences.

E. Alarm initiating zone modules.
   1. Shall supervise and accept remote alarm actuating device input signals. An alphanumeric readout shall indicate separate zone alarm and trouble indicators for each zone.
   2. Zones shall be compatible, and designed to operate with the connected initiating devices either addressable or non-addressable type.
   3. A spare double throw set of software programmable auxiliary alarm relay contacts shall be provided for control of remote devices for each zone. Contacts shall be rated 120-volt 60Hz 3 Ampere.
   4. Each device on the system shall report as its own unique address.

F. Notification alarm signal control.
   1. Shall supervise and activate remote notification alarm devices.
   2. Notification alarm shall be compatible and designed to properly operate with the connected audio and visual notification alarm devices, with no signal degradation.
   3. The notification alarm shall provide group notification signal control of all notification zones.
   4. The alarm modules shall be field resettable to provide either continuous or coded notification alarm signals. The coded alarm signal shall provide an intermittent "on-off" pulsed sound activation of audible notification alarm devices.
   5. A notification alarm circuit trouble indicating readout shall be provided for each notification zone.

G. Automatic ground detection shall detect either positive or negative voltages when earth connections of 50,000 OHMS or less occur, and activate the ground trouble signal.
   1. A ground fault code shall provide indication of either a positive or negative ground fault and shall operate the general trouble devices as specified herein but shall not cause an alarm to be sounded.
   2. A short circuit error message shall be a standard feature of the fire alarm control panel. Each communication loop shall be monitored for short circuits and shall have a distinctive error message for visual indication of circuits and operating trouble devices as specified herein but shall not cause an alarm to be sounded.

H. Power Supply
   1. The power supply shall be adequately sized to properly operate the equipment, including remotely connected, spare and future indicated equipment with all alarm devices in alarm condition. Provide 20% spare power supply capacity for future expansion. Provide transfer modules and multiple power supplies as required for proper operation.
   2. Input voltage 120/240 volt or 120/208 volt 60Hz AC.
   3. Surge transient voltage protection on the input and output phases of the power supply shall be provided.
   4. Supervised voltage types (i.e., 120-volt 60Hz AC, 24 volt AC, 24 Volt D.C., etc.) required by special connected equipment shall be supplied, including but not limited to:
      a. Alarm initiating devices.
      b. Notification alarm devices.
      c. Control and annunciator panels.
      d. Fire and smoke dampers.
   5. A solid-state power transfer circuit shall provide (UPS) uninterrupted power supply between internal standby power and line power automatically and instantaneously if normal power fails or falls below 15% of normal ("brown out" conditions).
   6. Individual circuit fuses shall be provided for smoke alarm detector power, main power supply notification circuits, battery standby power, and auxiliary output.

I. Battery Back-Up Operation
   1. Internal batteries and battery power supplies shall be provided to allow 60-hours continuous automatic normal operation of the entire control panel and fire alarm system after the failure of the incoming utility power. Sufficient battery capacity shall remain at the end of 60-hour period to provide ten minutes of continuous operation of all connected notification alarm devices.
   2. Batteries shall be maintenance free, sealed, lead-acid or lead calcium or gelled electrolyte type rated 25% larger than required to provide power for the entire system upon loss of normal 120 VAC power for a period of 60-hours with 5-minutes of alarm signaling at the end of this 60-hour period.
   3. The battery charger, shall be automatic, dual rate with capacity to recharge completely discharged batteries in 18 hours. Charger shall be temperature compensated.

J. Lightning and transient voltage surge protection shall be a standard feature of the fire alarm control panel and shall be incorporated in the power supply circuit, common control circuits, signal circuits, and telephone line circuit.

K. Circuitry shall be provided in the control panel to permit transmission of trouble and alarm signals over leased or privately owned telephone cables to a remote receiving panel. A reverse polarity or a master box circuit as required, shall be provided in the control panel. There shall be a supervised disconnect switch to allow testing of the fire alarm signal without transmitting an alarm signal to the central station.

L. The alpha numeric annunciator (printer and CRT/keyboard) shall list upon request:
1. Alarms with time, date and location.
2. Troubles with time, date and location.
3. Status of output functions, "on" or "off".
4. Sensitivity of addressable smoke detectors.
5. Detection device number, type and location.
6. Status of remote relays, "on" or "off".
7. Acknowledgment time and date.
8. Signal silence time and date.
9. Reset time and date.

M. The system shall also provide the following:
1. Counting the number of addressable detectors within a "zone".
2. Which are in alarm.
3. Counting "zones" which are in alarm.
4. Counting the number of addressable detectors which are in alarm.
5. Alarm on the system.
6. Differentiating among types of addressable detectors such as smoke detectors, manual stations, water-flow switches, thermal detectors.
7. Assigning priorities to types of detectors, zones or groups of detectors.
8. Cross-zoning.

M. CONTROL FUNCTIONS
1. Control functions shall be assigned on the basis of multi-relational system initiation patterns of detection devices including full logic element equations using as "anding" zones, counting zones, counting devices, "anding" groups, conditional "if", "then", "or" programming and "anding" types of detection devices.
2. Control functions shall be assigned on the basis of, cycle, delay, count, time of day, day of week, day of month and with a holiday schedule of up to 30-holidays per year. Each addressable detection device shall report its condition to the system control unit not less than every 4-seconds in a manner such that failure of the connections to the internal electronics of the device will result in a trouble signal which identifies the specific device involved.
3. The system shall be field programmable for the response of control points to monitored devices.
4. The operating software program shall provide programmable control for the Event-Initiated-Programs (E.I.P.) which shall allow automatic operation of system control points in the event of a alarm condition. To program these E.I.P.'s, the system shall use a specifically designed user friendly programming language, which shall not require a knowledge of computer programming to learn and understand.
5. The operating software shall support the following additional capabilities:
   a. Three levels of designated and unique Priority Alarms for each point.
   b. Designated "Sense Mode" for status interpretation for each point.
   c. Designated Print/No Print/Vectoring Mode for each point.
6. The input statement defines the conditions required to activate the associated output statement. The input statement shall consist of single or multiple monitor point status,

subroutine status, time comparison and the utilization of AND, OR, NOT, COUNT, and DELAY logic functions.

7. The output statement defines the action to be taken by the control panel. The output statement shall consist of activation/deactivation of single or multiple control functions, subroutines, and remote Annunciator status LED's. Output statements shall also include the "Alert" messages.
8. The software shall provide an "alert" message, unique to each point in the system, which will provide specific instructions for the operator on duty. These messages shall be up to five (5) lines with up to 70 characters in each line. Each system monitor point shall have five (5) specific alert messages when in alarm. Control points shall also be assigned alert messages.
9. The hardware and software shall have the capacity to accept up to 64 independent programs. Each program shall have "Edit" or "No Edit" capability. Each program shall be written in an equation format comparable to ladder-logic equations. The Equations shall consist of an input and an output statement.
10. Provide initial programming services for coding, loading and debugging the initial District specified programs, as part of the contract.
11. Programming Command Definition
    a. Timing command shall provide time delay and time control functions based on internal clock/calendar by time of day; day of week; day of month; month in year.
    b. Count command shall provide a specific number of events to occur before a control action is initiated.
    c. Pulse command shall provide on control for a specific period of time.
    d. Cycle command shall provide on-off control for preset periods of time.
    e. Print command shall provide printing of specified information after an event occurs.

2.03 FIRE ALARM DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Enclosure shall be red.

B. Panel shall be solid state with eight zones for off premise monitoring of the fire alarm control panel.

C. System shall monitor alarm and trouble conditions. System shall be power limited.

D. System shall include dual telephone line switcher for central station reporting. Telephone lines shall be supervised.

E. System shall include dual battery harness, batteries, and battery charger.

F. System shall be UL listed for central station fire signaling systems (NFPA 71).

G. System shall be California State Fire Marshal approved for central station reporting.

H. System shall be Radionics D8112FA Series or Simplex 5071 Series. System shall be approved for connection to the fire alarm control panel.

I. Verify specific requirements with District and central station prior to submittals.

2.04 MANUALLY ACTIVATED ALARM INITIATING DEVICES

A. An electronic, digital multiplex, addressable module shall be incorporated into each device. The module shall communicate the status and trouble condition of each device with a unique address code. The module shall communicate with and be supervised and monitored by the fire alarm control panel.

B. Devices shall be suitable for use on a class "B", 2-wire supervised alarm initiating circuit.

C. Numbered screw type terminals shall be provided for "in-out" connections of the alarm circuit wiring.

D. The face of the station shall have lettering indicating "FIRE" and operational instructions. Stations shall be tamper resistant, semi-flush mounting.

E. Auxiliary spare switch contact shall be provided for control of remote devices rated 120 volts - 60Hz, AC - 3AMP minimum.

F. Stations shall provide visual indication the station has been activated. A key (and/or special tool) shall be required to gain access into the station to reset the station after being activated.

G. Stations shall be "nonbreak-glass" type.

H. RF and transient filtering shall be provided in the device electronics.

I. Pull stations shall be non-coded double action, requiring a two (2) district manual "pulling" actions to initiate the fire alarm system.

J. Stations installed outdoors shall be weather resistant construction, double action to activate the pull station.

2.05 AUTOMATIC ALARM INITIATING DEVICES

A. General
1. An electronic digital, multiplex, addressable module shall be incorporated into each device. The module shall communicate the status and trouble condition of each device with a unique address code. The module shall communicate with and be supervised and monitored by the fire alarm control panel.
2. Devices shall be suitable for use on a Class "B", 2-wire supervised alarm initiating circuit. Where initiating devices are shown connected to an existing system, devices shall operated on 2 or 4-wire circuits plus, 2-wire power circuit as required by the existing equipment.
3. Numbered screw type terminals shall be provided for "in-out" connectors of the alarm circuit wiring.
4. Auxiliary double throw spare relay contact shall be provided for activation of remote rated devices 120-volt 60Hz, AC, 1 Ampere minimum.
5. RF and transient filtering shall be provided in the initiating device electronics.
6. Initiating devices shall be reset from the control panel and shall not require individual resetting.

B. Smoke Detector
1. Detectors shall comply with UL standard 268, 167 and 168, and shall use solid state electronic circuits throughout.
2. The smoke detector shall operate on a total of two circuit wires. Alarm signaling and detector power shall use the same conductors. Detector sensitivity shall be factory set at 1.5%.
3. A fine mesh insect screen shall be provided on all detector openings.
4. The detector shall lock-in on alarm and shall provide a visual alarm/trouble indicator light. An electromechanical test feature shall provide functional testing of the unit without smoke.
5. The detector shall also incorporate a fixed temperature heat detector rated at 135 degrees F. The heat detector shall operate the alarm circuit and alarm/trouble light.
   a. Photo electric type smoke detectors shall employ a light emitting diode (LED) as the detector light source, activated by the presence of combustion smoke products. Failure of the LED shall activate the alarm/trouble light on the detector.
   b. Ionization type smoke detector shall employ the triple chamber (dual chamber) ionization principle, activated by the presence of combustion products. The ionization chamber shall be RF shielded.
   c. Air duct smoke detector photo electric or ionization type for installation on a mechanical air ducts. Two air tubes shall extend into the air duct. The sampling tube shall extend across the entire width of the air duct. The second tube shall allow air to escape back into the duct.

C. Fire Detector - Heat
   1. Heat detectors shall be dual action electro-thermostatic combination rate of temperature rise and fixed temperature operation. An indicator shall be visible when detector has activated.
   2. The rate of rise element shall be self restoring, after activation.
   3. The fixed temperature unit shall be set at 136 degrees F (190 degrees F for high temperature areas i.e. over 110 degrees F.)
   4. Provide a wire guard cover for the detector.

D. Fire Sprinkler Water Flow Detector.
   1. Vane-type water flow detectors shall be provided on the sprinkler system piping as shown on the drawings. Detectors shall be designed for mounting on either vertical or horizontal piping, but shall not be mounted in a fitting or within 12 inches of any fitting that changes the direction of water flow.
   2. The detectors shall have a sensitivity setting to signal any flow of water that equals or exceeds the discharge from one sprinkler head.
   3. Detector switch mechanisms shall incorporate an instantly recycling pneumatic retard element with an adjustable range of 0 to 70 seconds. Switches shall have a minimum rated capacity of 7 amp 125 volt AC - .25 amp 24 volt D.C. A D.P.D.T. switch shall be actuated by a polyethylene vane extending into the waterway of the piping.
   4. Detectors shall be of weatherproof, dust tight construction and shall provide a ¾-inch conduit entrance. Detector shall be finished in red baked enamel.
   5. Flow switch shall be sized to match the fire sprinkler riser pipe diameter.

E. Fire Sprinkler Valve Tamper Switch
   1. Tamper switch shall monitor the position of the fire sprinkler shut-off valve. Operation of the valve shall activate the switch and activate a trouble alarm.

2.06 NOTIFICATION ALARM DEVICES

A. General
   1. Notification alarm devices shall activate automatically from the control panel. Devices shall operate on a Class "B" (Style Y), 2-wire supervised alarm notification circuit. Series wired alarm devices shall not be used.
   2. Numbered screw type terminals shall be provided for "in-out" connections of the alarm circuit wiring.
   3. Devices shall be installed in a box, 3½-inches deep maximum, flush mounting unless indicated otherwise on the drawings. Size as required for the alarm indicating device and wiring connections. Provide a trim ring and metal grill cover assembly. Cover assembly shall be minimum of 1/16-inch minimum thick flat stainless steel or aluminum. Finish color as selected by Architect. The word "fire" shall appear on the grill minimum ½-inch letters. The grill shall be attached with screws to the box.
   4. Each audible notification visual devices shall incorporate a visual alarm indicator. The visual alarm indicating device shall be an integral part of the audible alarm box assembly.
   5. Audible notification device and visual notification devices shall be connected to separate notification alarm signal circuits. Do not connect these devices to the same circuit conductors.

B. Audible Alarm Horns
   1. Horns installed indoors shall be electronic type.
   2. Horn shall provide a minimum sound level of 75dB at 10 feet, when installed in the field operating conditions shown on the drawings.
   3. Outdoor horns shall be electro-mechanical, weatherproof and shall be mounted in a recessed backbox with vandal resistant grille, Soundolier 193-8/VP-161 series.
   4. Audible devices shall provide a minimum sound level of 10dB over the ambient level measured 48-inches above the floor.

C. Visual Alarm Indicator
   1. Lamp/Strobe internally illuminated projecting lens assembly, with flasher system. Unit shall flash on and off to provide visual indicating of fire alarm.
   2. The word "fire" shall appear on the lens or lens plate.
   3. Flash rate, one flash per second, with a flash duration of approximately 0.001 second, flash rate independent of audible device.
   4. Light source, Xenon high intensity flash strobe tube white/clear color.
   5. Strobe shall have a minimum output of 75 candela with a maximum flash intensity of 120 candela.
   6. Strobe shall comply with NFPA requirements.

2.07 REMOTE FIRE ALARM ANNUNCIATOR

A. General
   1. The annunciator panel shall be powered and operated from the fire alarm control panel. "In-out" circuit conductors shall terminate on numbered screw-type terminals.
   2. A metal tamper resistant weatherproof cabinet shall contain the annunciator components. The panel shall be surface or flush mounted as indicated on the drawings. Provide a full height tamper resistant, hinged locking cabinet door. Door shall have transparent high impact windows to allow visual observation of all indicators and switches.
   3. An electronic digital, multiplex, addressable module shall be incorporated into the annunciator. The module shall communicate the status and trouble condition of each device with a unique address code. The module shall communicate with and be supervised and monitored by the fire alarm control panel.

B. Each alarm initiating zone (including spares) shall be individually annunciated in the annunciator panel.

C. A common fire trouble alarm shall be annunciated in the annunciator panel from the fire alarm control panel.

D. Annunciator lamp circuits shall be automatically supervised. Provide lamp test switch in the annunciator panel.

E. An audible alarm/trouble buzzer with silence switch and automatic resound for subsequent alarm/trouble signals shall be provided. The annunciator panel shall be automatically reset when the control panel is reset.

F. A keyed switch shall be provided for remote reset of the system. The annunciation panel shall also be automatically reset when the control panel is reset.

G. Provide a floor plan of the facility framed under acrylic and mounted adjacent to the fire alarm annunciator. The floor plan shall be to scale and shall have room numbers clearly displayed on all rooms corresponding to the annunciator for the purpose of easily identifying the fire zones.

2.08 REMOTE EQUIPMENT MONITORING AND CONTROL

A. An electronic digital multiplex addressable module shall be provide at each device or equipment indicated to be controlled by the multiplex system. Multiple addressable control ports shall be provided in each module quantity as required for each point controlled or monitored. The module shall communicate the monitor status control action and trouble condition of each device with a unique address code. The module shall communicate with and be supervised and monitored by the fire alarm control panel.

B. Where multiple points are monitored or controlled, provide digital, multiplex, multipoints, monitor, control panel (MMCP). The panel cabinet shall be self contained NEMA 1 construction and hinged locking door. Provide tamper switch detection zone on the cabinet door, provide 60 hour battery UPS backup and power supply, the same as required for the fire alarm control

panel. Panel shall be expandable using plug-in circuit monitor/control printed circuit cards. Provide barriered numbered terminal strips.

C. Each control point shall provide a supervised "dry" relay contact single pole double throw maintained contact rated 10 ampere, 227 volt, 60Hz AC.

D. Each monitor point shall provide not less than one of the following supervised methods of monitoring a remote device or equipment action or status.
   1. Remote "dry" contact operation normal open, normally closed or momentary contact operation.

PART 3 EXECUTION

3.01 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. The inside cover of alarm initiating devices shall be marked with the zone initiating number corresponding to the zone number in the control panel. Marking shall be with a felt-tip pen.

B. Each fire alarm terminal cabinet shall be painted red.

C. Provide nameplate: "Power to Main Fire Alarm Control Panel" screwed onto the branch circuit overcurrent device supplying power to the main fire alarm control panel.

3.02 WIRING (ADDITIONAL REQUIREMENTS)

A. Review the total system point-to-point wiring layout to assure that the correct number and type of wires and conduit sizes are installed.

B. Final connections, testing, adjusting and calibration shall be made under the direct supervision of a factory-trained technician of the system supplier.

C. All wiring shall be in conduit.

D. All wiring in cabinets shall be neatly formed, laced and made up on bolt and nut terminal blocks. Tag all spare conductors. All conductors shall terminate on terminal strips with spade lugs, of adequate size for all incoming and outgoing conductors. The strips shall be labeled as to their use and wiring diagram shall be placed on the cabinet door showing connections of all related equipment to these strips.

E. Wiring requirements for shielding certain conductors shall be as recommended by the manufacturer. Provide all conduit, raceways and conductors per manufacturers recommendations and include all material and labor costs in the contract price.

F. The conductors used for digital, multiplex communication between the fire alarm control panel and external remote initiation devices, control points and annunciators, shall be twisted, shielded, multi-conductor cable, #16AWG copper minimum with a separate internal ground/drain conductor, UL listed for fire alarm system use. One (1) spare pair of multiplex conductors shall be provided in all main and branch device/equipment connections for future system use. "Tees" and taps at any junction box location in the communication lines, shall be permitted by the system to additional devices without affecting proper system operation.

G. Wire Size: Wire shall be sized to insure installed circuit voltage drop does not exceed 10% to all devices.

3.03 OUTLET BOXES (ADDITIONAL REQUIREMENTS)

Device outlet boxes shall be flush mounted unless indicated otherwise on the drawings. Provide extension rings to finish flush with finish surface. Where the drawings indicate surface mounted devices, outlet boxes shall be cast metal with threaded hubs. Where the conduit entrances are not exposed for surface mounted devices, provide flush outlet box behind the device box, and omit the conduit hubs on the device box. Size device boxes and outlet boxes per manufacturer's recommendation and as required by code for wire fill.

3.04 SPECIAL INSTALLATION REQUIREMENTS

A. Air duct smoke detectors shall be installed in the supply air ducts and return air ducts with an air flow of 2000 CFM or greater, coordinate with mechanical contractor. Sampling tube shall extend across entire duct width. Provide ¾-inch conduit with 2#12 to respective motor control device to automatically shut down the respective fan motor upon detection of smoke in the air duct.

B. Water flow switches shall be installed on each main fire sprinkler rise pipe, coordinate with the fire sprinkler contractor.

C. Tamper switches shall be installed on each main fire sprinkler shut-off valve, coordinate with the fire sprinkler contractor.

D. Equipment shall be weatherproof gasketed where installed in locations exterior to the building, or where indicated on the drawings. Weatherproof equipment shall be tamper resistant.

E. Provide clear vandal resistant protective cover for all audio-visual devices located in student restrooms and public hallways.

F. Provide wire guard for ceiling mounted smoke and heat detectors located in student restrooms.

G. Connect fire alarm control panel with security/intrusion control panel for monitoring by remote monitoring company.

H. Connect fire alarm control panel with master clock system to turn off class passing schedule, with paging system to turn off system when fire alarm system in alarm condition.

I. Conduit with fire alarm wiring shall be painted red.

J. Fire alarm system shall be programmed per actual building and room designation. Submit printout for review.

3.05 TESTING

A. The entire fire alarm system shall be tested in the presence of the local DSA Inspector and a representative of the manufacturer after the installation is complete.
   1. Individually activate each manual initiating station and verify correct alarm operation and control panel response.
   2. Individually test each automatic initiating device and verify correct alarm operation, control panel response and remote equipment operation.
   3. The communication loops and the notification alarm circuits shall be opened in at least two (2) locations per building to check for the presence of correct supervisory circuitry.

B. Test the battery back-up system by disconnecting the incoming normal power and allowing this alarm system to operate 24 hours on battery power. Sound the alarm system for 5-minutes at the end of 24 hours on battery power.

C. Perform all electrical and mechanical tests required by the equipment manufacturer's certification form. Measure and adjust each automatic detection detector to the maximum stable sensitivity setting. Detector tests shall be performed with the detector at its operational location and under normal operational environmental conditions in the area. Bench settings are not acceptable. An operational check-out test and report shall be performed. Submit six (6) copies of test report results. The tests and report shall include, but not be limited to:
   1. A complete list of equipment installed and wired.
   2. Indication that all equipment is properly installed and functions and conforms with these specifications.
   3. Test of individual zones as applicable.
   4. Serial numbers locations by zone and model number for each installed detector.

5. Voltage (sensitivity) settings for each ionization and photoelectric detector as measured in place with the HVAC system operating.
6. Technician's name, certificate number and date.
7. The completed manual and automatic monitoring and control system shall be tested to insure that it is operating properly. This test will consist of exposing the installed units to a standard fire test.
8. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a 90-day test period without any unwarranted alarms. Should an unwarranted alarm(s) occur, the contractor shall readjust or replace the equipment and detector(s) and begin another 90-day test period. As required by the Architect, the contractor shall recheck the detectors using the fire test after each readjustment or replacement of detectors. This test shall not start until the District has obtained beneficial use of the building under tests.

D. After the testing has been completed to the satisfaction of the inspectors, provide the NFPA certificate of compliance to the District, the local Fire Official, the Architect and DSA.

E. Upon the receipt of Certificate of Compliance, the installer/supplier shall supply the District with a written operating, testing and maintenance instructions, point-to-point as-built drawings, and equipment specifications on DVD.

3.06 Provide four (4), 2-hour instructional sessions conducted by a factory-authorized technician at the job site after completion of all tests to instruct School District personnel on the use of the system. The first session shall be audio/visually recorded to a DVD and provided to the District, and conducted prior to Beneficial Occupancy. This first session shall be with site staff (as designated by site administrator) and FASO Maintenance Technicians. and conducted prior to final acceptance of the project.

The second 2-hour session shall be conducted and audio/visually recorded on DVD and will be training for the FASO Maintenance Technicians within 1 month of Occupancy.

The third 2-hour session shall be conducted within 8 months of Occupancy, during normal working hours.

The fourth 2-hour session shall be held within eleven months of final acceptance of the project, when requested by the District. District will schedule in advance and during normal working hours, Monday through Friday.

END OF SECTION

SECTION 31 1000

SITE CLEARING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Protection of existing trees indicated to remain.

2. Removal of trees and other vegetation.

3. Topsoil stripping and stockpiling.

4. Clearing and grubbing.

5. Removing above-grade improvements.

6. Removing below-grade improvements.

B. Related Sections:

1. "Temporary Facilities and Controls" Section for temporary utility services, construction and support facilities, and security and protection facilities.

2. "Execution" Section for field engineering and surveying.

3. "Construction Waste Management and Disposal" and "Sustainable Design Requirements" Section for additional LEED requirements.

4. "Structure Demolition" Section for demolition of buildings, structures, and site improvements.

5. "Selective Structure Demolition" Section for partial demolition of buildings or structures.

1.03 PROJECT CONDITIONS

A. Traffic: Conduct site-clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction.

B. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements indicated to remain in place.

1. Protect improvements on adjoining properties and on Owner's property.

2. Restore damaged improvements to their original condition, as acceptable to property owners. The full width of pavements damaged due to construction access and other construction-related activities shall be replaced with a structural section (pavement and base) at least equal to the adjacent existing section.

3. Protect existing utility lines indicated to remain. Notify Owner immediately of any damage to or encounter with an unknown existing utility line. Immediately repair damage to existing utility lines.

C. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place against unnecessary cutting, breaking or skinning of roots, ANY skinning or bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to be left standing.

1. Water trees and other vegetation to remain within limits of contract work as required to maintain their health during course of construction operations.

2. Provide protection for roots over 1-1/2 inch in diameter that are cut during construction operations. Coat cut faces with an emulsified asphalt or other acceptable coating formulated to use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.

3. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations in a manner acceptable to Architect. Employ a licensed arborist to repair damage to trees and shrubs.

4. Replace trees that cannot be repaired and restored to full-growth status, as determined by arborist.

D. Improvements on Adjoining Property: Authority for performing removal and alteration work on property adjoining Owner's property will be obtained by Owner prior to award of contract.

1. Extent of work on adjacent property is indicated on Drawings.

E. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated or directed.

F. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place. Contractor shall abide by all conditions in the Storm Water Pollution Prevention Plan Prepared by others.

G. Soil stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

1.04 EXISTING SERVICES

A. General: Indicated locations are approximate; determine exact locations before commencing Work.

B. Arrange and pay for disconnecting, removing, capping, and plugging utility services. Notify affected utility companies in advance and obtain approval before starting this Work.

C. Place markers to indicate location of disconnected services. Identify service lines and capping locations on Project Record Documents.

PART 2 - PRODUCTS

2.01 NONE

PART 3 - EXECUTION

3.01 SITE CLEARING

A. General: Remove shrubs, grass, and other vegetation, improvements, or obstructions, as required, to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated. Removal includes digging out and off-site disposal of stumps and roots.

1. 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.

2. Unless specifically designated to remain, strip the upper two inches (minimum) of soil containing vegetation and root growth within the Limits of Work shown on the Drawings.

B. Topsoil: Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material.

1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.

a. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.

2. Stockpile topsoil in storage piles in areas indicated or directed. Construct storage piles to provide free drainage of surface water. Cover storage piles, if required, to prevent wind erosion. Limit height of stockpiles to 72 inches.

3. Dispose of unsuitable or excess topsoil as specified for disposal of waste material.

C. Clearing and Grubbing: Clear site of trees, shrubs, and other vegetation, except for those indicated to be left standing.

1. Completely remove stumps, roots, and other debris protruding through ground surface.

2. Use only hand methods for grubbing inside drip line of trees indicated to remain.

3. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.

a. Place fill material in horizontal layers not exceeding 8 inches loose depth, and thoroughly compact each layer and compact in accordance with the requirements specified in Division 31 Section “Earth Moving” to make the new surface conform with the existing adjacent surface of the ground.

4. Trim trees, designated to be left standing within the cleared areas, of dead branches 1-1/2 inches or more in diameter; and trim all branches to heights and in a manner as indicated. Neatly cut limbs and branches to be

trimmed close to the bole of the tree or main branches. Paint cuts more than 1-1/4 inches in diameter with specified tree-wound paint.

D. Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.

1. Abandonment or removal of certain underground pipe or conduits may be indicated on mechanical or electrical drawings. Removing abandoned underground piping or conduits interfering with construction are included under this Section.

3.02 DISPOSAL OF WASTE MATERIALS

A. Burning on Owner's Property: Burning is not permitted on Owner's property.

B. Removal from Owner's Property: Remove waste materials and unsuitable or excess topsoil from Owner's property.

C. 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. Do not interfere with other project work.

END OF SECTION

SECTION 31 1200

DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Demolition and removal of buildings.Removal of trees and other vegetation.

2. Demolition and removal of structures.

3. Demolition and removal of site improvements.

4. Disconnecting, capping or sealing, and abandoning site utilities in place.

5. Disconnecting, capping or sealing, and removing site utilities.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. "Cutting and Patching" Section for cutting and patching procedures for demolition operations.

2. Division 1 Section "Schedules and Reports" Section for demolition schedule requirements

3. Division 1 Section "Construction Facilities and Temporary Controls" Section for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and environmental protection measures for demolition operations.

4. “Contract Closeout" Section for record document requirements.

5. "Selective Demolition" Section for partial demolition of a building or structure undergoing alterations and for the removal, salvage, or reuse of materials in new construction.

6. "Tree Protection and Trimming" Section for protecting trees remaining on-site.

7. "Site Clearing" Section for site clearing and removing above- and below-grade improvements.

8. "Earth Moving" Section for soil materials, excavating, backfilling, and site grading.

1.03 DEFINITIONS

A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.

B. Remove and Salvage: Items indicated to be removed and salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Owner's designated storage area.

C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in locations indicated.

D. Existing to Remain: Protect construction indicated to remain against damage and soiling during demolition. When permitted by the Architect, items may be removed to a suitable, protected storage location during demolition and then cleaned and reinstalled in their original locations.

1.04 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, salvaged, or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.

B. Historical items indicated remain the Owner's property. Carefully remove and salvage each item in a manner to prevent damage and deliver promptly to the Owner.

C. Historical items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to the Owner, which may be encountered during demolition, remain the Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to the Owner.

1. Cooperate with Owner's archaeologist or historical adviser.

1.05 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections, for information only, unless otherwise indicated.

B. Proposed dust-control measures.

C. Proposed noise-control measures.

D. Schedule of demolition activities indicating the following:

1. Detailed sequence of demolition and removal work, with starting and ending dates for each activity.

2. Dates for shutoff, capping, and continuation of utility services.

E. Inventory of items to be removed and salvaged.

F. Inventory of items to be removed by Owner.

G. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by demolition operations.

H. Record drawings at Project closeout according to "Contract Closeout" Section.

1. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.

I. Landfill records for record purposes indicating receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.06 QUALITY ASSURANCE

A. Demolition Firm Qualifications: Engage an experienced firm that has successfully completed demolition Work similar to that indicated for this Project.

B. Regulatory Requirements: Comply with governing EPA notification regulations before starting demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Pre-demolition Conference: Conduct conference at Project site to comply with pre-installation conference requirements of Division 1 Section "Project Meetings."

1.07 PROJECT CONDITIONS

A. Buildings to be demolished will be vacated and their use discontinued before start of Work.

B. Owner assumes no responsibility for actual condition of buildings to be demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Asbestos: It is not expected that asbestos will be encountered in the course of this Contract. If any materials suspected of containing asbestos are encountered, do not disturb the materials. Immediately notify the Architect and the Owner.

1. Asbestos will be removed by Owner before start of Work.

D. Asbestos: Asbestos is present in the building or structure to be demolished. A report on the presence of asbestos is on file for review and use. Examine the report to become aware of locations where asbestos is present.

1. Asbestos abatement is specified elsewhere in the Contract Documents.

2. Do not disturb asbestos or any material suspected of containing asbestos except under the procedures specified elsewhere in the Contract Documents.

E. Storage or sale of removed items or materials on-site will not be permitted.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Requirements for satisfactory soil materials are specified in "Earth Moving" Section.

1. Obtain approved borrow soil materials off-site when sufficient satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of demolition required.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

D. Survey the condition of the building to determine whether removing any element might result in a structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during demolition.

E. Perform surveys as the Work progresses to detect hazards resulting from demolition activities.

3.02 UTILITY SERVICES

A. Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.

1. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.

a. Provide not less than 72 hours' notice to Owner if shutdown of service is required during changeover.

B. Owner will arrange for disconnecting and sealing indicated utilities serving structures to be demolished before start of demolition work, when requested by Contractor.

C. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services serving structures to be demolished.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.

2. Arrange to shut off indicated utilities with utility companies.

D. Utility Requirements: Refer to “Electrical” and “Mechanical” Sections for shutting off, disconnecting, removing, and sealing or capping utility services. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.03 PREPARATION

A. Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with demolition operations.

B. Employ a certified, licensed exterminator to treat building and to control rodents and vermin before and during demolition operations.

C. Conduct demolition operations and remove debris 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 Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

D. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around demolition area.

1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.

2. Protect existing site improvements, appurtenances, and landscaping to remain.

3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.

E. Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of buildings to be demolished and adjacent buildings to remain.

1. Strengthen or add new supports when required during progress of demolition.

3.04 EXPLOSIVES

A. Explosives: Use of explosives will not be permitted.

B. Explosives: Do not bring explosives to the site or use explosives without written consent of Owner and authorities having jurisdiction. Such written consent will not relieve Contractor of total responsibility for injury to people or for damage to property due to blasting operations. Perform required blasting in compliance with governing regulations.

3.05 POLLUTION CONTROLS

A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.

1. Do not create hazardous or objectionable conditions, such as ice, flooding, and pollution, when using water.

B. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

1. Do not create hazardous or objectionable conditions, such as ice, flooding, and pollution, when using water.

C. Clean adjacent buildings and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before start of demolition.

3.06 POLLUTION CONTROLS

A. Building Demolition: Demolish buildings completely and remove from the site. Use methods required to complete Work within limitations of governing regulations and as follows:

1. Locate demolition equipment throughout the building and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

2. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.

3. Small buildings may be removed intact when permitted by Architect and approved by authorities having jurisdiction.

4. Demolish concrete and masonry in small sections.

5. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

6. Break up and remove concrete slabs on grade, unless otherwise shown to remain.

7. Remove air-conditioning equipment without releasing refrigerants.

B. Below-Grade Construction: Demolish foundation walls and other below-grade construction, as follows:

1. Remove below-grade construction, including foundation walls, to at least 12 inches (300 mm) below grade.

2. Remove below-grade construction, including foundation walls and footings, to the depths indicated.

3. Completely remove below-grade construction, including foundation walls and footings.

4. Break up and remove below-grade concrete slabs, unless indicated to remain.

5. Break up below-grade concrete slabs into sections no larger than 24 inches (600 mm) square and leave in place.

C. Filling Below-Grade Areas: Completely fill below-grade areas and voids resulting from demolition of buildings and pavements with soil materials according to requirements specified in Division 2 Section "Earthwork."

D. Damages: Promptly repair damages to adjacent facilities caused by demolition operations.

3.07 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

B. Burning: Do not burn demolished materials.

C. Burning: Burning of demolished materials will be permitted only at designated areas on Owner's property, providing required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

D. Disposal: Dispose of demolished materials at designated spoil areas on Owner's property.

E. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

END OF SECTION

SECTION 31 2000

EARTH MOVING

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 SUMMARY

A. This Section includes the following:

1. Preparing and grading sub-grades for slabs-on-grade, walks, pavements, and landscaping.

2. Excavating and backfilling for buildings and structures.

3. Drainage and moisture-control fill course for slabs-on-grade.

4. Base course for walks and pavements.

5. Subsurface drainage backfill for walls and trenches.

6. Excavating and backfilling trenches within building lines.

7. Excavating and backfilling for underground utilities and appurtenances outside building lines.

B. Related Sections: The following Sections contain requirements that relate to this Section.

1. "Cast-in-Place Concrete" Section for concrete encasings, cradles, and appurtenances for utility systems.

2. "Site Clearing" Section for site stripping, grubbing, topsoil removal, and tree protection.

3. "Turf and Grasses" Section for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.

4. "Plants" Section for finish grading in planting areas and tree and shrub pit excavation and planting.

5. “Subdrainage” Section for drainage of foundations.

1.03 REFERENCE SPECIFICATION

A. Perform all work in accordance with applicable provisions of "Standard Specifications for Public Works Construction", latest edition. Unless otherwise noted, mention herein of section numbers refers to sections of the Reference Specification. Where Reference Specification refers to "Agency", substitute the word "Owner". Where Reference Specification refers to "Engineer", substitute the word "Architect". Where Reference Specification is in conflict with these Specifications, these Specifications shall govern.

1.04 DEFINITIONS

A. Excavation: Consists of the removal of material encountered to subgrade elevations and the re-use or disposal of materials removed.

B. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below aggregate base, drainage fill, or topsoil materials.

C. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.

D. Base Course: The layer placed between the subgrade and surface pavement in a paving system.

E. Drainage Fill: Course of washed granular material supporting slab-on-grade placed to cut off upward capillary flow of pore water.

F. Unauthorized Excavation: Consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Architect. Unauthorized excavation, as well as remedial work directed by the Architect, shall be at the Contractor's expense.

G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.

H. Utilities: Include on-site underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

I. Compaction: Any method of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of Compaction" is expressed as a percentage of the maximum dry density obtained by the test procedure described in ASTM D 1557 for general soil types abbreviated in this Specification as "___ percent of maximum dry density".

J. Hard Material: Weathered rock, dense consolidated deposits or conglomerate materials which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

K. Lift: A layer or course of soil placed on top of previously prepared or placed soil in a fill or embankment.

L. Unsatisfactory Material: Soil or other material identified as having insufficient strength or stability to carry intended loads without excessive consolidation or loss of stability.

1.05 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

1. Location of borrow materials.

B. Photographs or video tape of existing adjacent structures and site improvements.

1.06 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.

B. Testing and Inspection Service: Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soils to verify that soils comply with specified requirements and to perform required field and laboratory testing.

C. Testing and Inspection Service: Employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soils to verify that soils comply with specified requirements and to perform required field and laboratory testing.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings."

1. Before commencing earthwork, meet with representatives of the governing authorities, Owner, Architect, consultants, Geotechnical Engineer, independent testing agency, and other concerned entities. Review earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least 3 working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.

1.07 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted in writing by the Architect and then only after acceptable temporary utility services have been provided.

1. Provide a minimum 48-hours' notice to the Architect and receive written notice to proceed before interrupting any utility.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shutoff services if lines are active.

C. Groundwater elevations that may be indicated are those existing at the time that subsurface investigations were made and do not necessarily represent groundwater elevations at the time of construction.

D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures are in place.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide approved borrow soil materials from off-site when sufficient approved soil materials are not available from excavations.

B. Satisfactory Soil Materials: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.

C. Unsatisfactory Soil Materials: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.

D. Backfill and Fill Materials: Satisfactory soil materials.

E. Base Material: Shall conform to crushed aggregate base or fine-gradation crushed miscellaneous base in accordance with section 200-2.2 or 200-2.4, respectively, of the Reference Specification, and compacted to at least 95% of the maximum dry density as determined by ASTM Test Method D 1557.

F. Engineered Fill: Well graded granular soil with an expansion index less than 20 and free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.

G. Bedding Material: Shall be base materials with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve; or clean sand classified in accordance with ASTM D 2487.

H. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D 448, coarse aggregate grading size 57, with 100 percent passing a 1-1/2-inch sieve and not more than 5 percent passing a No. 8 sieve.

I. Filtering Material: Evenly graded mixture of natural or crushed gravel or crushed stone and natural sand, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 50 sieve.

J. Sand: ASTM C33, fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.02 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.

B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick minimum, 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 2'-6" deep.

1. Tape Colors: Provide tape colors to utilities as follows:

a. Red: Electric.
b. Yellow: Gas, oil, steam, and dangerous materials.
c. Orange: Telephone and other communications.
d. Blue: Water systems.
e. Green: Sewer systems, incl. storm drain.
f. White: Steam systems.

C. Filter Fabric: Manufacturer's standard non-woven pervious geotextile fabric of polypropylene, nylon or polyester fibers, or a combination.

1. Provide filter fabrics that meet or exceed the listed minimum physical properties determined according to ASTM D 4759 and the referenced standard test method in parentheses:

a. Grab Tensile Strength (ASTM D 4632): 120 lb.
b. Apparent Opening Size (ASTM D 4751): #70 U.S. Standard sieve.

c. Permeability (ASTM D 4491): 150 gallons per minute per sq. ft.

D. Filter Fabric for Infiltration Trenches

1. A Class “C” geotextile or better shall interface between the trench side walls and between the stone reservoir gravel filter layers. A partial list of non-woven filter fabrics that meet the lass “C” criteria follows. Any alternative filter fabric must be approved by the Architect.

a. Mirafi 180-N
b. Amoco 4552
c. Webtec N70
d. Geolon N70
e Carthage FX-80S

E. Separation Geotextile: Manufacturer's standard woven geotextile, 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. Apparent Opening Size: No. 60 (0.250-mm) sieve maximum, ASTM D 4751.

3. Permittivity: 0.02 per second minimum, ASTM D 4491.

4. UV Stability: 50 percent after 500 hours’ exposure, ASTM D 4355.

PART 3 - EXECUTION

3.01 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. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Tree protection is specified in the "Site Clearing” Section.

D. Prepare subgrade and place base materials in accordance with sections 301-1.2 and 301-2, respectively, of the Reference Specification.

3.02 DEWATERING

A. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

3.03 EXCAVATION

A. General: Shall be to the contours and dimensions indicated. Keep excavations free from water and debris while construction is in progress. Notify the Owner immediately in writing where it becomes necessary to remove hard, soft, weak, or wet material to a depth greater than indicated. Unless otherwise indicated, concrete placed below grade will be formed and excavations shall allow for placement and removal of forms. Side cuts shall be cribbed and shored as required.

B. Explosives: Do not use explosives.

C. Unclassified Excavation: Excavation is unclassified and includes excavation to required subgrade elevations regardless of the character of materials and obstructions encountered.

3.04 STABILITY OF EXCAVATIONS

A. Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.

B. Unshored Temporary Excavations: Unshored temporary excavations may be sloped back at 1 to 1 (horizontal to vertical) or flatter. Where sloped embankments are used, the tops of the slopes should be barricaded to prevent vehicles and storage loads within seven feet of the tops of the slopes. If the temporary construction slopes will be maintained during the rainy season, construct berms along the tops of the slopes where necessary to prevent run-off water from entering the excavation and eroding the slope faces.

3.05 EXCAVATION FOR STRUCTURES

A. Excavation Limits: Shall be to a tolerance of plus-or-minus 0.10 foot and shall extend at least five feet laterally beyond the building limits at the excavation level. The excavation side slopes shall not exceed a slope ratio of 1 to 1, horizontal to vertical, unless they are positively retained by shoring or other approved methods. Over-excavation side slopes may be vertical, as long as they are no higher than allowed by the State of California Construction Safety Orders, in which case they

shall be no steeper than 1 to 1. If cut below depths indicated, excavations shall be filled with concrete when the foundations or footings are placed.

1. Excavations for Footings and Foundations:

   a. 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.

   b. Excavations shall be such that all footings be founded on at least 2 feet of properly compacted soil. This 2 feet shall consist of compacted fill; or, in cases where the footing bottom would otherwise be in cut, may consist of as little as one feet of over-excavation, with one foot of scarified and compacted existing soil beneath the excavation (i.e. the total over-excavation may only need to be 2 feet). This determination shall be made in the field by the geotechnical engineer.

2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Appurtenances: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot. Do not disturb bottom of excavations intended for bearing surface.

3.06 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavations shall be such that all walks and pavements are founded on at least 2 feet of properly compacted soil. This determination shall be made in the field by the geotechnical engineer.

3.07 EXCAVATION FOR UTILITY TRENCHES

A. Excavation made with power-driven equipment is not permitted within two feet of any known utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, use hand or light equipment excavation. Start hand or light equipment excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines and other existing work affected by the excavation work of this Section until approval for backfill is granted by the geotechnical engineer. Immediately report damage to utility lines or subsurface construction to the Owner.

B. Where unidentified existing utilities are encountered, determine whether these are active or abandoned. Remove interfering portions of abandoned utilities and cap or plug open ends of pipe to remain. The cap or plug must seal the opening in such a manner that would permit remaining portions of the utility to be reactivated. Notify Owner for instructions on utilities which are determined to be active. Do not proceed without instructions, except to correct an immediate hazard or emergency condition. Relocation work performed on an active utility

without obtaining prior approval from Owner shall be done at the Contractor's expense and liability.

C. In areas where compacted backfill has been placed, additional consolidation may occur after completion due to changes in moisture content and surcharge. Utility connections crossing this backfill, and improvements adjoining the building at the backfill line shall be installed taking into account this additional consolidation, or sufficient time shall be scheduled between backfilling operations and such improvements to allow this consolidation to take place. Damage to utilities or other improvements due to Contractor's negligence in regard to this paragraph shall be repaired at the Contractor's expense.

D. Protect newly backfilled areas and adjacent structures, slopes, or grades from traffic, erosion settlement, and any other damage. Repair and re-establish damaged or eroded grades and slopes and restore surface construction prior to acceptance.

E. Cutting Pavement, Curbs, and Gutters: Saw cut with neat, parallel, straight lines one foot wider than trench width on each side of trenches and one foot beyond each edge of pits. If an existing pavement joint or cracked area is within two feet outside of a designated sawcut line shown on the Drawings, removal and resurfacing shall be to that joint, and/or shall include the crack or cracked area, unless otherwise approved by Architect.

F. Contractor shall pothole at all identifiable crossings of existing utilities prior to any trenching operations and provide Architect with a survey of the top elevations (and bottom elevations, if applicable), of possible interferences so that an evaluation of necessary adjustments to the current profile or alignment may be made. Additionally, Architect shall be given the opportunity to view possible conflicts in the field prior to providing revised designs.

G. Provide a minimum cover from grade of 3 feet for water mains and gas mains. Storm drains and sewers shall be to the depths indicated. Where settlements greater than the tolerance allowed herein for grading occur in trenches and pits due to improper compaction, excavate to the depth necessary to rectify the problem, then backfill and compact the excavation as specified herein and restore the surface to the required elevation.

H. Keep excavations free from water while construction is in progress.

I. Notify the Owner immediately in writing if it becomes necessary to remove rock or hard, unstable, or otherwise unsatisfactory material to a depth greater than indicated. Excavate large rock, boulders, and other unyielding material to an overdepth at least 6 inches below the bottom of the pipe, conduit, duct and appurtenances, unless otherwise indicated or specified. Over-excavate soft, weak,

or wet excavations to an overdepth at least 12 inches below the bottom of the pipe, conduit, duct or appurtenances unless otherwise indicated or specified.

J. Excavate trenches to indicated slopes, lines, depths, and invert elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

K. Excavate trenches to uniform widths to provide a working 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, except where sloping of sides is allowed. Sides of trenches shall not be sloped from the bottom of the trench up to the elevation of the top of the pipe. See plans for detail.

L. At the option of the Contractor, the excavations may be cut to an overdepth of not less than 4 inches and refilled to required grade as specified.

M. 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 stones and sharp objects to avoid point loading.

1. For pipes or 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. Dig bell holes and depressions for joints after trench has been graded. Dimension of bell holes shall be as required for properly making the particular type of joint to ensure that the bell does not bear on the bottom of the excavation.

3.08 APPROVAL OF SUBGRADE

A. Notify Architect when excavations have reached required subgrade.

B. When Architect determines that unforeseen unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

1. Unforeseen additional excavation and replacement material will be paid according to the Contract provisions for changes in Work.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Architect.

3.09 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending indicated bottom elevation of concrete foundation or footing to excavation bottom, without altering required top elevation. Lean concrete fill with 28-day compressive strength of 2500 psi (17.2 MPa), may be used to bring elevations to proper position when acceptable to the Architect.

1. Fill unauthorized excavations under other construction as directed by the Architect.

B. Where indicated widths of utility trenches are exceeded, provide stronger pipe, or special installation procedures, as required by the Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust.

1. Stockpile soil materials away from edge of excavations a minimum distance of 7 feet or depth of excavation, whichever is greater. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Backfill excavations promptly, but not before completing the following:

1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.

2. Surveying locations of underground utilities for record documents.

3. Testing, inspecting, and approval of underground utilities.

4. Concrete formwork removal.

5. Removal of trash and debris from excavation.

6. Removal of temporary shoring and bracing, and sheeting.

7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.12 UTILITY TRENCH BACKFILL AND COMPACTION

A. Backfilling of exterior utility trenches shall not be undertaken until geotechnical engineer has received 24-hours notice, until required tests and inspections have been completed, and until as-built location notes have been furnished. Remove uninspected backfill in accordance with requirements of this specification. Use hand-operated, plate-type, vibratory, or other suitable hand tampers in areas not accessible to larger rollers or compactors. Avoid damaging pipes and protective pipe coatings.

B. Place backfill material in accordance with Section 306-1.3.2 of the Reference Specifications and achieve at least 90% of the maximum density per ASTM D 1557. The top 12 inches of backfill in the building or paved areas shall be compacted to 95% of maximum density per ASTM D 1557.

C. Compaction by ponding or flooding will not be permitted.

D. Place and compact bedding course on rock and other unyielding bearing surfaces and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

E. Concrete backfill trenches that carry below or pass under footings and that are excavated within 18 inches of footings. Place concrete to level of bottom of footings.

F. Provide 4-inch-thick concrete base slab support for piping or conduit with less than 2'-6" of cover below finish surface of roadways. After installation and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway base.

G. Place and compact initial backfill of satisfactory soil material or aggregate base material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit.

   1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

H. Coordinate backfilling with utilities testing.

I. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.

J. Place and compact final backfill of satisfactory soil material to final subgrade.

K. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

L. Manholes and other appurtenances: Provide at least 12 inches clear from outer surfaces to the embankment or shoring. Remove rock as specified herein. Remove unstable soil that is incapable of supporting the structure to an over-depth of one foot and refill with gravel or sand to the proper elevation and compact to 95% percent of maximum density.

3.13 FILL

A. Preparation: Remove vegetation, topsoil, debris, wet, and unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placing fills.

1. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing surface.

B. When subgrade or existing ground surface to receive fill has a density less than that required for fill, break up ground surface to depth required, pulverize, moisture-condition or aerate soil and re-compact to required density.

C. Place fill material in layers to required elevations for each location listed below.

1. Under grass, use satisfactory excavated or borrow soil material.

2. Under walks and pavements, use base material or satisfactory excavated or borrow soil material.

3. Under steps and ramps, use base material.

4. Under building slabs, use drainage fill material.

5. Under footings and foundations, use engineered fill.

3.14 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to minimum 2 percent above optimum moisture content for cohesive soils and to near optimum for cohesionless soils.

1. Do not place backfill or fill material on surfaces that are muddy, frozen or contain frost or ice.

2. Remove and replace, or scarify and air-dry satisfactory soil material that is too wet to compact to specified density.

a. Stockpile or spread and dry removed wet satisfactory soil material.

3.15 COMPACTION

A. Place backfill and fill 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 materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure. Keep rollers and other heavy equipment at least 18 inches from footings, foundations, piers and walls of buildings and accessory construction. Use mechanical and hand tampers weighing at least 90 pounds with a maximum face area of 48 inches square to compact backfill within 18 inches of construction and where access is restricted.

C. Percentage of Maximum Dry Density Requirements: Compact soil to not less than the following percentages of maximum dry density according to ASTM D 1557:

1. For general site fills, compact each layer of backfill or fill material at 90 percent maximum dry density.

2. Under structures, building slabs, steps, and pavements, scarify and compact the top 12 inches below subgrade at 95 percent maximum dry density.

3. Under walkways, scarify and compact the top 6 inches below subgrade at 90 percent maximum dry density.

4. Under lawn or unpaved areas, compact the top 6 inches below subgrade at 85 percent maximum dry density.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between existing adjacent grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to conform to required surface tolerances.

3. All hillside grading or construction of fill slopes shall conform to the minimum standards listed in Chapter 70 of the UBC.

4. Fill slopes shall be keyed and benched into firm, natural ground when the existing slope to receive the fill is 5:1 or steeper (horizontal to vertical). Keys shall be tilted into the slope, shall be a minimum of one equipment width wide and shall be a minimum of three feet deep at the outside edge.

5. If necessary, the Contractor's selected equipment and construction procedure shall be altered, changed or modified in order to meet the specified compaction requirements. Flooding and water jetting is prohibited.

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 0.10 foot, unless otherwise indicated.

2. Concrete Walks: Plus or minus 0.05 foot.

3. Pavements:

a. Concrete: 0.02 foot minus, with no high spots.

b. Asphalt: 0.05 foot minus, with no high spots.

C. Grading Inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 BASE COURSE

A. Under pavements and walks, place base course material on prepared subgrades to pavements.

1. Compact base courses at optimum moisture content to required grades, lines, cross sections and thickness to not less than 95 percent relative compaction in accordance with ASTM D 1557 and ASTM D 4718.

2. Shape base to required crown elevations and cross-slope grades.

3. When thickness of compacted base course is 6 inches or less, place materials in a single layer.

4. When thickness of compacted base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

3.18 PAVEMENT REPAIR

A. Repair or patch asphalt pavement as specified in Asphalt Paving Section. Repair or patch concrete pavement, curbs and gutters as specified in Concrete Paving Section. Do not repair pavement until trench has been backfilled and compacted as herein specified.

3.19 FIELD QUALITY CONTROL

A. Testing Agency Services: Allow testing agency to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.

1. Perform field in-place density tests according to ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method), or ASTM D 2937 (drive cylinder method), as applicable.

    a. Field in-place density tests may also be performed by the nuclear method according to ASTM D 6938, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D 6938.

    b. When field in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Architect.

2. Footing Subgrade: At footing subgrades, perform at least one test of each soil stratum to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of each subgrade with related tested strata when acceptable to the Architect.

3. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2,000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.

4. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 100 feet or less of wall length, but no fewer than two tests along a wall face.

5. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 150 feet or less of trench, but no fewer than two tests.

B. When testing agency reports that subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required. Re-compact and retest until required density is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace material to depth directed by the Architect; reshape and re-compact at optimum moisture content to the required density.

C. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.21 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 Owner's property.

END OF SECTION

SECTION 32 1216

ASPHALT PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.

2. Hot-mix asphalt patching.

3. Asphalt surface treatments:

a. Fog seals.
b. Slurries.

4. Subgrade preparation.

B. Related Sections include the following:

1. “Earth Moving” Section for aggregate base courses and aggregate pavement shoulders.

1.03 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt pavement and/or pervious asphalt paving according to the materials, workmanship, and other applicable requirements of the following standard specifications:

1. Reference Specification: Perform all work in accordance with applicable provisions of "Standard Specifications for Public Works Construction", latest edition. Unless otherwise noted, mention herein of section numbers refers to sections of the Reference Specification. Where Reference Specification refers to "Agency", substitute the word "Owner". Where Reference Specification refers to "Engineer", substitute the word "Architect". Where Reference Specification is in conflict with these Specifications, these Specifications shall govern.

2. Measurement and payment provisions and safety program submittals included in Reference Specifications do not apply to this Section.

3. The latest edition of the Asphalt Institute's publication "The Asphalt Handbook".

4. Standard Specifications, July 1999 or latest edition; California Department of Transportation (Caltrans).

5. California Test Methods, latest edition; California Department of Transportation (Caltrans) Transportation Laboratory.

6. Standards of the American Association of State Highway and Transportation Officials (AASHTO), 1998 or latest edition. Standards of the American Association of State Highway and Transportation Officials (AASHTO), 1998 or latest edition.

1.04 SUBMITTALS

A. Product Data: For each product specified. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: For each job mix proposed for the Work.

C. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.

C. Regulatory Requirements: Conform to applicable standards of authorities having jurisdiction for asphalt paving work on public property.

E. Asphalt-Paving Publication: Comply with Asphalt Institute's "The Asphalt Handbook," except where more stringent requirements are indicated.

F. Pre-installation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination"

Review methods and procedures related to asphalt paving including, but not limited to, the following:

1. Review condition of substrate and preparatory work performed by other trades.

2. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

3. Review and finalize construction schedule for paving and related work. Verify availability of materials, paving Installer's personnel, and equipment required to execute the Work without delays.

4. Review inspection and testing requirements, governing regulations, and proposed installation procedures.

5. Review forecasted weather conditions and procedures for coping with unfavorable conditions.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:

1. Prime and Tack Coats: Minimum surface temperature of 60 deg F (15.6 deg C).

2. Slurry Coat: Comply with weather limitations of ASTM D 3910.

3. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.

4. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.

5. Pervious Bituminous Paving Mixtures: Minimum surface temperature of 55 deg. F (12.5 deg. C) at time of placement.

PART 2 - PRODUCTS

2.01 ASPHALT PAVEMENT MATERIALS

A. Asphalt Pavement Leveling Course: Conform to Performance Grade B-PG 64-10 in section 203-1.2 and section 203-6 of the Reference Specification.

B. Asphalt Pavement Wearing (Surface) Course : Conform to Performance Grade III C2-PG 64-10 or III C3-PG 64-10 in section 203-1.2, section 203-6 and section 400-4 to be used with Class III asphalt of the Reference Specification.

C. Full Depth Asphalt: When asphalt is to be laid in one lift, conform to Asphalt Concrete Leveling Course.

D. Prime Coat: Grade SC-70 liquid asphalt conforming to section 203-2 of the Reference Specification.

E. Tack Coat: Emulsified asphalt grade SS-1h conforming to section 203-3 of the Reference Specification.

F. Asphalt Paint: conform to ASTM D41 or D43 per Section 203-8 of the Reference Specification.

G. Slurry Seal: Emulsified asphalt grade SS-1h or CSS-1h and aggregate conforming to section 203.5 of the Reference Specification.

H. Fog Seal: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

I. Water: Potable.

2.02 AUXILIARY MATERIALS

A. Herbicide Treatment: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide granular, liquid, or wettable powder form.

B. Sand: ASTM D 1073, Grade Nos. 2 or 3.

C. Wheel Stops: Pre-cast, air-entrained concrete, 2500-psi (17.2-MPa) minimum compressive strength, approximately 6 inches (150 mm) high, 9 inches (225 mm) wide, and length as shown, reinforced with two No. 3 deformed steel bars. Provide chamfered corners and drainage slots on underside, and provide holes for anchoring to substrate.

1. Dowels: Galvanized steel, diameter 3/4 inch (19 mm), minimum length 10 inches (254 mm).

PART 3 – EXECUTION (HOT-MIX ASPHALT)

3.01 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Subgrade and Base:

1. Proof-roll subgrade and base course using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Notify Architect in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been satisfactorily corrected.

3.02 COLD MILLING

A. Cold mill existing asphalt concrete pavement in accordance with section 302-5.2 of the Reference Specification.

3.03 PATCHING AND REPAIRS

A. Patching: Saw cut perimeter of patch and excavate existing pavement section to sound base. Re-compact new subgrade. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.

1. Tack coat faces of excavation and allow to cure before paving.

2. Fill excavation with dense-graded, hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

3. Partially fill excavation with dense-graded, hot-mix asphalt base mix and compact while still hot. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slabs until slab is stabilized or, if necessary, crack slab into pieces and roll to re-seat pieces firmly.

2. Remove disintegrated or badly broken pavement. Prepare and patch with hot-mix asphalt.

C. Leveling Course: Install and compact leveling course consisting of dense-graded, hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.

D. Crack and Joint Filling: Remove existing filler material from cracks or joints to a depth of 1/4 inch (6 mm). Refill with asphalt joint-filling material to restore watertight condition. Remove excess filler that has accumulated near cracks or joints.

E. Asphalt paint: Apply uniformly to existing surfaces of previously constructed asphalt or Portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m) of surface.

1. Allow asphalt paint to cure undisturbed before paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.04 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.

1. Sweep loose granular particles from surface of unbound aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

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.

1. Mix herbicide with prime coat when formulated by manufacturer for that purpose.

C. Prime Coat: Comply with section 302-5.3 of the Reference Specification. Apply primer at a rate of between 0.20 and 0.25 gallons per square yard to top surface of base course prior to asphalt placement.

D. Tack Coat: If a leveling course has been used for construction traffic, apply tack coat to all leveling course surfaces in accordance with section 302-5.4 of the Reference Specification at a rate of 0.10 gallons per square yard.

E. Asphalt Paint: Apply uniformly to existing surfaces of previously constructed asphalt or Portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m) of surface.

1. Allow asphalt paint to cure undisturbed before paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.05 GEOTEXTILE INSTALLATION

A. Apply bond coat, consisting of asphalt cement, uniformly to existing surfaces at a rate of 0.20 to 0.30 gal./sq. yd. (0.8 to 1.2 L/sq. m).

B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches (100 mm) and transverse joints 6 inches (150 mm).

1. Protect paving geotextile from traffic and other damage and place overlay paving the same day.

3.06 HOT-MIX ASPHALT PLACING

A. The asphalt pavement shall be completed in phases; the leveling course during construction for temporary construction traffic and storage of materials and; the wearing (surface) course just prior to turnover to Owner; unless the entire paving operation is completed just prior to turnover to the Owner. If this method is chosen, then no construction traffic or storage of materials shall be allowed on the finished pavement surface after its completion. Contractor shall schedule final surface course paving operations so that the required waiting period specified in the "Pavement Marking" Section will allow project completion within the specified time.

B. Construct asphalt pavement in accordance with section 302-5 of the Reference Specification and as shown on the Drawings.

C. Two Layer Method: The leveling course shall be installed to elevations which will allow the future placement of a wearing (surface) course no thinner than 1-1/2 inches. Prior to placing the wearing (surface) course, repair all areas damaged during construction use , thoroughly clean the leveling course of all loose material and place a tack coat pursuant to paragraph 3.4.D. herein.

Contractor is further cautioned that the use of this two-layer method will result in construction traffic using pavements which are thinner than designed for the

traffic expected for the completed project, and that damage due to wheel loads and materials storage during construction is probable. Any such damage shall be repaired to the satisfaction of the Architect and the Owner prior to placement of the surface course.

3.07 JOINTS

A. Construct joints to ensure 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.

2. Offset longitudinal joints in successive courses a minimum of 6 inches (150 mm).

3. Offset transverse joints in successive courses a minimum of 24 inches (600 mm).

4. Construct transverse joints by bulkhead method or sawed vertical face method as described in AI's "The Asphalt Handbook."

5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.08 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 vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and re-rolling to required elevations.

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: 96 percent of reference laboratory density according to ASTM D 1559, but not less than 94 percent nor greater than 100 percent.

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 still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method.

F. Repairs: Remove paved areas that are defective, pond water or are contaminated with foreign materials. Remove paving course over area affected and replace with fresh, hot-mix asphalt, with a thickness one inch greater than the existing, and to match existing finish surface grades such that no local ponding of water will result. Compact by rolling to specified density and surface smoothness. Note that no application of seal coats of any kind will be allowed for any reason on pavements newer than one year. This is to allow for proper curing of the newly placed asphalt pavement, as recommended by The Asphalt Institute.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.09 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Leveling Course: Plus or minus 1/2 inch (13 mm).

2. Surface Course: Plus 1/4 inch (6 mm), no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:

1. Leveling Course: 1/4 inch (6 mm).

2. Surface Course: 1/8 inch (3 mm).

3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

3.10 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.70 L/sq. m) to existing asphalt pavement and allow to cure. Lightly dust areas receiving excess fog seal with a fine sand.

B. Slurry seals: Apply in accordance with section 302-4 of the Reference Specification.

1. Roll slurry seal to smooth ridges and provide a uniform, smooth surface.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. Finish Grade: Completed pavement surface shall be tested for proper drainage through flood testing. Contractor shall schedule a flood test to be held in the presence of the Architect and the Owner to assure that the finished pavement surfaces are consistent with the intent of the Grading Plans with respect to surface drainage, and that drainage devices function properly. It is suggested that a water truck or fire hose be used for the flooding; garden hoses will not be acceptable. Pavements not deemed acceptable subsequent to this test shall be removed and replaced pursuant to paragraph 3.3 herein. Overlays with thicknesses less than 1-1/2 inches will not be acceptable for these repairs.

F. In-Place Density: Samples of uncompacted paving mixtures and compacted pavement will be secured by testing agency according to ASTM D 979.

1. Reference laboratory density will be determined by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 1559, and compacted according to job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

    a. One core sample will be taken for every 1000 sq. yd. (836 sq. m) or less of installed pavement, but in no case will fewer than 3 cores be taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

G. Replace and compact hot-mix asphalt where core tests were taken.

H. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION

SECTION 32 4100

STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes drainage systems outside the building. Systems include the following:

1. Storm drainage.

B. Related Sections: The following Sections contain requirements that relate to this Section.

1. "Subdrainage" Section for foundation drain connecting to storm drainage system.

2. "Cast-in-Place Concrete" Section for cast-in-place concrete structures.

3. "Facility Storm Drainage Piping" Section for building drains.

1.03 SYSTEM DESCRIPTION

A. Provide systems according to the materials, workmanship, and other applicable requirements of the standard specifications of the state or of authorities having jurisdiction.

1. Reference Specification: Perform all work in accordance with applicable provisions of "Standard Specifications for Public Works Construction", latest edition. Unless otherwise noted, mention herein of section numbers refers to sections of the Reference Specification. Where Reference Specification refers to "Agency", substitute the word "Owner". Where Reference Specification refers to "Engineer", substitute the word "Architect". Where Reference Specification is in conflict with these Specifications, these Specifications shall govern.

2. Measurement and payment provisions and safety program submittals included in Reference Specifications do not apply to this Section.

1.04 DEFINITIONS

A. Drainage Piping: System of pipe, fittings, and appurtenances for gravity flow of storm drainage.

1.05 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Non-pressure Piping Pressure Ratings: At least equal to system test pressure.

1.06 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product data for the following:

1. Pipe and fittings

2. Cleanouts and drains.

C. Inspection and test reports specified in the "Field Quality Control" Article.

1.07 QUALITY ASSURANCE

A. Environmental Agency Compliance: Comply with regulations pertaining to storm drainage systems.

B. Utility Compliance: Comply with regulations pertaining to storm drainage systems. Include standards of water and other utilities where appropriate.

C. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components and are based on specific manufacturer types indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Section "Substitution Procedures."

1.08 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe or fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast concrete manholes and other structures according to manufacturer's rigging instructions.

1.09 PROJECT CONDITIONS

A. Perform site survey, research public utility records and/or pothole as necessary to verify existing utility locations. Contact utility locating service for area where Project is located.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.

1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without receiving Architect's written permission.

1.10 SEQUENCING AND SCHEDULING

A. Coordinate storm drainage system connections to utility company's storm drain.

B. Coordinate storm drainage system connections to existing on-site storm drain.

C. Coordinate with interior building drainage systems.

D. Coordinate with other utility work.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Cleanouts and Drains:

a. Josam Co.
b. Jay R. Smith Mfg. Co. Div., Smith Industries, Inc.
c. Wade Div., Tyler Corp.
d. Zurn Specification Drainage Operation Div., Zurn Industries, Inc.

2.02 PIPES AND FITTINGS

A. Corrugated-Steel Pipe: ASTM A 760/A 760M, Type I, made from ASTM A 444/A 444M, zinc-coated steel sheet for banded joints.

1. Fittings: Fabricated to types indicated and according to same standards as pipe.

2. Connecting Bands: Standard couplings made for corrugated-steel pipe to form soiltight joints.

3. Protection: Pipe and coupling bands shall receive a bituminous coating in accordance with the Reference Specification, paragraph 207-11.5.

4. Linings: Bituminous or concrete linings shall be applied to the interior of the pipe as specified in paragraph 207-11.5.3 of the Reference Specification.

5. Slotted Pipe: Shall conform to paragraph 207-11.7 of the Reference Specification.

B. Corrugated-Aluminum Pipe: ASTM B 745/B 745M, Type I, made from ASTM B 744/B 744M, aluminum-alloy sheet for banded joints.

1. Fittings: Fabricated to types indicated and according to same standards as pipe.

2. Connecting Bands: Standard couplings made for corrugated-aluminum pipe to form soiltight joints.

3. Flared End Sections: Shall be prefabricated galvanized steel.

C. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints.

1. Primer: ASTM F 656.

2. Solvent Cement: ASTM D 2564.

3. Gaskets: ASTM F 477, elastomeric seal.

D. Vitrified Clay Piping for Gravity Flow: ASTM C 700 bell-and-spigot piping with ASTM C 425 compression joints.

E. Reinforced Concrete Storm Drain Pipe and Fittings: ASTM C 76, Class as shown. Circular pipe with elliptical reinforcement shall have a readily visible line at least 12 inches long painted or otherwise applied on the inside and outside of the pipe at each end so that when the pipe is laid in the proper position, the line will be at the center of the top of the pipe. Fittings and specials shall conform to the same strength as the pipe.

1. Jointing Materials: Gaskets and pipe ends for rubber gasket joint shall conform to ASTM C 443. Gaskets shall be suitable for use with sewage.

   a. O-Ring Gasketed bell and spigot, all concrete, with bell cast integrally with pipe, ASTM C 443.
   b. Tongue and groove, cement mortared with mortar made of one part Type II Portland Cement to two parts sand.

F. High Density Polyethylene Pipe (HDPE) for gravity flow, smooth interior and annular exterior corrugations. Gasketed integral bell–and-spigot joint meeting the requirements of ASTM F2736. Provide pipe per Paragraph 207-18 of the Reference specification.

2.03 SPECIAL PIPE COUPLINGS AND FITTINGS

A. Sleeve-Type Pipe Couplings: Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined, for non-pressure joints.

1. Sleeves for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.

2. Sleeves for Plastic Pipe: ASTM F 477, elastomeric seal.

3. Sleeves for Dissimilar Pipes: Compatible with pipe materials being joined.

4. Bands: Stainless steel, at least one at each pipe insert.

B. Gasket-Type Pipe Couplings: Rubber or elastomeric compression gasket, made to match outside diameter of smaller pipe and inside diameter or hub of adjoining larger pipe, for non-pressure joints.

1. Gaskets for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.

2. Gaskets for Plastic Pipe: ASTM F 477, elastomeric seal.

3. Gaskets for Dissimilar Pipes: Compatible with pipe materials being joined.

2.04 MANHOLES

A. Precast Concrete Manholes: Per SPPWC Standard Plan 321-2 “Manhole Pipe-to-Pipe (One or Both Main Line ID’s 33” or Smaller)”.

B. Manhole Frames and Covers: Per SPPWC Standard Plan 630-3 “24” Manhole Frame and Cover”.

1. After installation of manhole and after installation of adjacent paving, if any, covers shall be sandblasted and painted with black bituminous paint.

2.05 CATCH BASINS

A. Cast-in-Place Concrete Catch Basins-Grated: Construct of reinforced-concrete, designed according to ASTM C 857 for structural loading and as shown on the Drawings. Include depth, shape, dimensions, and appurtenances indicated.

1. Bottom, Walls, and Top: Reinforced concrete.

2. Channels and Benches: Concrete.

3. Steps: Fiber glass, individual steps. Omit steps for catch basins less than 48 inches (1500 mm) deep.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, heavy-duty ductile iron for A-16 structural loading, and as shown on Drawings.

C. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to SPPWC Standard Plan 300-3 "Curb Opening Catch Basin".

D. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to SPPWC Standard Plan 302-3 "Curb Opening Catch Basin with Grating(s). Include heavy-duty frames and grates. See Drawings for number of grates.

E. Frames and Grates: Heavy-duty frames and grates according to SPPWC Standard

Plan 311-3 "Frame and grating for Catch Basins".

2.06 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.

2. Fine Aggregate: ASTM C 33, sand.

3. Coarse Aggregate: ASTM C 33, crushed gravel.

4. Water: Potable.

B. Structures: Portland-cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cement ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.

2. Reinforcement Bars: ASTM A 615, Grade 60 (ASTM A 615M, Grade 400), deformed steel.

C. Structure Channels and Benches: Factory or field formed from concrete. Portland-cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cement ratio.

1. Include channels and benches in manholes.

a. Manhole Channels: Concrete invert, formed to same width as connected piping, with height of the vertical sides to 3/4 of the pipe diameter. Form curved channels with smooth, uniform radius and slope. If channel invert slope is not indicated on the Drawings, slope as follows:
1) Invert Slope: 2.5 percent (1:40) through manhole.

b. Manhole Benches: Concrete, sloped to drain into channel.
1) Slope: 1 inch per foot (1:12).

2.07 CLEANOUTS

A. Description: Round, gray-iron housing with round, secured, scoriated, cast-iron cover as detailed on the Drawings. Include gray-iron ferrule with inside caulk or spigot connection and countersunk, tapered-thread, brass closure plug. Use units with top-loading classifications according to the following applications:

1. Light Duty: In earth or grass, foot-traffic areas.

2. Medium Duty: In paved, foot-traffic areas.

3. Heavy Duty: In vehicle-traffic service areas.

4. Extra Heavy Duty: In roads.

B. After installation of cleanout cover and after installation of adjacent paving, if any, covers shall be sandblasted or wire brushed as necessary and painted with bituminous black paint, unless another color is required by the Architect.

2.08 DRAINS

A. Area Drains: ASME A112.21.1M, round, gray-iron body with anchor flange and round, secured, cast-iron grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated. Use units with top-loading classifications according to the following applications:

1. Medium Duty: In paved, foot-traffic areas.

2. Heavy Duty: In vehicle-traffic service areas.

B. Cast-Iron Trench Drains: ASME A112.21.1M, 6-inch- (152-mm-) wide top surface, rectangular body with anchor flange or other anchoring device and rectangular, secured grate. Include units of total lengths indicated and number of bottom outlets with inside calk or spigot connections, of sizes indicated. Use units with top-loading classifications according to the following applications:

1. Medium Duty: In paved, foot-traffic areas.

2. Heavy Duty: In vehicle-traffic service areas.

3. Extra Heavy Duty: In roads.

C. Steel Trench Drains: Fabricated from ASTM A 242/A 242M steel plate, to form rectangular body with uniform bottom slope of 2 percent down toward outlet, anchor flange, and grate. Include units of total lengths indicated, bottom outlet of size indicated, outlet strainer, and acid-resistant enamel coating on inside and outside surfaces. Include grate openings with total free area at least 2 times the outlet cross-sectional area and with the following features:

1. Plate Thickness: 1/4 inch (6.4 mm).

2. Plate Thickness: 1/8 inch (3.2 mm).

3. Overall Width: 7-1/2 inches (190 mm).

4. Overall Width: 12-1/3 inches (313 mm).

5. Grate: 3-by-3/8-inch (76-by-9.5-mm) slots.

6. Grate: 3/8-inch- (9.5-mm-) diameter openings.

7. Grate: 1/4-inch- (6.4-mm-) diameter openings.

8. Cover: Solid with diamond pattern, where indicated.

9. Weepholes in body and flashing clamping ring for units used with waterproof membrane.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in the “Earth Moving” Section.

3.02 IDENTIFICATION

A. Materials and their installation are specified in the “Earth Moving” Section. Arrange for installation of green warning tapes directly over piping and at outside edges of underground structures.

1. Use warning tapes or detectable warning tape over ferrous piping.

2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.03 DRAINAGE PIPING APPLICATIONS

A. General: Include watertight, silttight, or soiltight joints, except where watertight or silttight joints are indicated.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to the following applications.

C. Pipe Sizes 4 to 15 Inches (100 to 375 mm): ASTM D 3034, polyvinyl chloride (PVC) sewer pipe and fittings; solvent-cemented joints; or with gaskets and gasketed joints.

C. Pipe Sizes 4 to 15 Inches (100 to 375 mm): ASTM D 1248, high-density polyethylene (HDPE) bell-and-spigot drainage pipe; gasketed joints.

D. Pipe Sizes 15 to 36 Inches (375 to 900 mm): Reinforced-concrete storm drain pipe and fittings; rubber gaskets and gasketed joints; or tongue-in-groove, mortared joints.

3.04 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Special Pipe Couplings: Use where indicated and where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

1. Use the following pipe couplings for non-pressure applications:

a. Straight-pattern, sleeve type to join piping, of same size, with small difference in outside diameters.
b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
c. Gasket type to join piping of different sizes where annular space between smaller piping's outside diameter and larger piping's inside diameter permits installation.
d. Internal-expansion type to join piping with same inside diameter.

3.05 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground drainage system piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed. Verify existing elevations prior to extensive excavating and notify Architect of any discrepancies. Contractor shall be liable for any premature construction which must be modified due to unforeseen existing conditions.

C. Use fittings for branch connections.

D. Use proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.

E. Install gravity-flow-systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.

F. Extend drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

G. Install drainage piping pitched down in direction of flow, at minimum slope of 1 percent (1:100) and 36-inch (1000-mm) minimum cover, except where otherwise indicated.

3.06 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to the following.

B. Polyvinyl Chloride (PVC) Plastic Pipe and Fittings: As follows:

1. Join solvent-cement-joint pipe and fittings with solvent cement according to ASTM D 2855 and ASTM F 402.

2. Join pipe and gasketed fittings with elastomeric seals according to ASTM D 2321.

C. Concrete Pipe and Fittings: Install according to ACPA "Concrete Pipe Handbook." Use the following seals:

1. Round Pipe and Fittings: ASTM C 443 (ASTM C 443M), rubber gaskets or tongue-in-groove with mortar.

D. High Density Polyethylene (HDPE) drainage pipe: Install in accordance with ASTM D2321.

E. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and fit both systems' materials and dimensions.

3.07 MANHOLE INSTALLATION

A. General: Install manholes, complete with accessories, as indicated.

B. Form continuous concrete channels and benches between inlets and outlet, where indicated.

C. Set tops of frames and covers flush with finished surface where manholes occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere, except where otherwise indicated.

D. Place precast concrete manhole sections as indicated, and install according to ASTM C 891.

1. Provide rubber joint gasket complying with ASTM C 443 (ASTM C 443M), at joints of sections.

3.08 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.09 DRAIN INSTALLATION

A. Install type of drains in locations indicated. Embed drains in 4-inch minimum concrete around bottom and sides.

B. Fasten grates to drains if indicated.

C. Set drain frames and covers with tops flush with pavement surface.

3.10 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318, ACI 350R, and as indicated.

3.11 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from storm drain pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.

B. Set cleanout frames and covers in earth in a cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding earth grade.

C. Set cleanout frames and covers in concrete paving with tops flush with surface of paving.

3.12 TAP CONNECTIONS

A. Make connections to existing piping and underground structures so finished work conforms as nearly as practical to requirements specified for new work.

B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of 3000-psi (20.7-MPa), 28-day, compressive-strength concrete.

C. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.13 CLOSING ABANDONED DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping that is indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either of the following procedures:

1. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Structures: Excavate around structure as required and use the following procedure:

1. Remove structure and close open ends of remaining piping.

2. Backfill to grade according to the Earth Moving Section.

3.14 FIELD QUALITY CONTROL

A. Clean interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.

2. Place plug in end of incomplete piping at end of day and whenever work stops.

3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of the Project.

1. Submit separate reports for each system inspection.

2. Defects requiring correction include the following:

   a. Alignment: Less than full diameter of inside of pipe is visual between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 92.5 percent of piping diameter.
   c. Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.

4. Re-inspect and repeat procedure until results are satisfactory.

C. Test new piping systems and parts of existing systems that have been altered, extended, or repaired for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to authorities having jurisdiction.

3. Schedule tests, and their inspections by authorities having jurisdiction, with at least 24 hours' advance notice.

4. Submit separate reports for each test.

5. Where authorities having jurisdiction do not have published procedures, perform tests per UNI-B-6 and the following:

   a. Exception: Piping and soiltight joints unless required by authorities having jurisdiction.
   b. Option: Test plastic piping according to ASTM F 1417.
   c. Option: Test concrete piping according to ASTM C 924.

6. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).

7. Leaks and loss in test pressure constitute defects that must be repaired.

8. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

3.15 STANDARD PLANS

A. The following Standard Plans have been specified on the Drawings and are included following this Section for Contractor's convenience:

1. Standard Plans for Public Works Construction Standard Plan 300-3 "Curb Opening Catch Basin". (2 sheets)

2. Standard Plan for Public Works Construction Standard Plan 302-3 "Curb Opening Catch Basin with Grating(s)". (2 sheets)

3. Standard plans for Public Works Construction Standard Plan 308-2 "Monolithic Catch Basin Connection". (2 sheets)

4. Standard Plans for Public Works Construction Standard Plan 321-2 "Manhole Pipe to Pipe (One or Both Main Line ID's 33" or Smaller)". (3 sheets)

5. Standard Plans for Public Works Construction Standard Plan 335-2 "Pipe Connections to Existing Storm Drains". (3 sheets)

END OF SECTION