FINAL

DSA DIVISION OF THE STATE ARCHITECT
DEPARTMENT OF GENERAL SERVICES

DSA-103 Issued 12/30/2016

List of Required Structural Tests & Special Inspections - 2016 CBC

INCREMENT #

DSA File No.: 19-41

Application No.: 03-118364

Date Submitted: 8/23/2017

Revised:

Revised:

School Name	John Muir Elementary School	District	Glendale Unified School District

IMPORTANT: This form is only a summary list of structural tests and some of the special inspections required for the project. Generally, the structural tests and special inspections noted on this form are those that will be performed by the Geotechnical Engineer of Record, Laboratory of Record, or Special Inspector. The actual complete test and inspection program must be performed as detailed on the DSA approved documents. The appendix at the bottom of this form identifies work NOT subject to DSA requirements for special inspection or structural testing. The project inspector is responsible for providing inspection of all facets of construction, including but not limited to, special inspections not listed on this form such as structural wood framing, high-load wood diaphragms, cold-formed steel framing, anchorage of non-structural components, etc., per Title 24, Part 2, Chapter 17A.
NOTE: This form is also available for projects submitted for review under the 2007, 2010, and 2013 CBC.

INSTRUCTIONS: Click a plus sign (+) before any category or subcategory to reveal additional tests and special inspections. A shaded box indicates a test or special inspection that may be required, depending on the scope of the construction and other issues. A shaded box can be clicked indicating your selection of that test. **Note:** A minus (-) on a category or subcategory heading indicates that it can be collapsed. However, any selections you may have made will be cleared. Click on the "COMPILE" button to show only the tests and inspections finally selected. **For more information on use of this form, see DSA-103.INSTR.**

Note: References are to the 2016 edition of the California Building Code (CBC) unless otherwise noted.

REQUIRED	TEST OR SPECIAL INSPECTION	TYPE[1]	PERFORMED BY[2]	CODE REFERENCE AND NOTES
+	**SOILS**			
-	**CONCRETE**			**Table 1705A.3, ACI 318-14 Sections 26.12 & 26.13**
-	**11. POST-INSTALLED ANCHORS:**			
X	a. Inspect installation of post-installed anchors	See Notes	SI*	**Table 1705A.3 Item 4a (Continuous) & 4b (Periodic)** (see Appendix for exemptions). ACI 318-14 Sections 17.8 & 26.13 * May be performed by the project inspector when specifically approved by DSA.
X	b. Test post-installed anchors.	Test	LOR	**1910A.5** (1909.2.7+). (See Appendix for exemptions.)
+	**MASONRY**			**TMS 402-13/ACI 530-13/ASCE 5-13 Table 3.1.3 & TMS 602-13/ACI 530.1-13/ASCE 6-13 Table 5**
-	**STEEL, ALUMINUM**			**Table 1705A.2.1, AISC 303-10, AISC 360-10, AISC 341-10, AISC 358-10, AISI S100-07/S2-10**
-	**17. STRUCTURAL STEEL, COLD-FORMED STEEL, AND ALUMINUM USED FOR STRUCTURAL PURPOSES**			
	Material Verification:			
X	a. Verify identification of all materials and: • Mill certificates indicate material properties that comply with requirements, • Material sizes, types and grades comply with requirements.	Periodic	*	**2203A.1** (2203.1+), **Table 1705A.2.1 Item 3a-3c;** AISI S100-07/S2-10 Section A2.1 & A2.2, AISI S200-12 Section A3, AISI S220-11 Section A4. * By special inspector or qualified technician when performed off-site.
X	b. Test unidentified materials	Test	LOR	**2203A.1** (2203.1+).
	Inspection:			
X	e. Verify and document steel fabrication per DSA approved construction documents.	Periodic	SI	Not applicable to cold-formed steel light-frame construction, except for trusses (**1705A.2.4**).
-	**19. WELDING:**			**1705A.2.5, Table 1705A.2.1 Items 4 & 5;** DSA IR 17-3, AWS D1.1 and AWS D1.8 for structural steel, AWS D1.2 for Aluminum, AWS D1.3 for cold-formed steel, AWS D1.4 for reinforcing steel. (See Appendix for exemptions.)

+ In the CODE REFERENCE AND NOTES column indicates DSA-SS/CC sections that may be used by community colleges, per 2013 6 CBC Sec. 1.9.2.2.

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	Verification of Materials, Equipment, Welders, etc:			
X	**a.** Verify weld filler material identification markings per AWS designation listed on the DSA approved documents and the WPS.	**Periodic**	**SI**	DSA IR 17-3.
X	**b.** Verify weld filler material manufacturer's certificate of compliance.	**Periodic**	**SI**	DSA IR 17-3.
X	**c.** Verify WPS, welder qualifications and equipment.	**Periodic**	**SI**	DSA IR 17-3.
-	**19.2 FIELD WELDING:**			
X	**b.** Inspect single-pass fillet welds ≤ 5/16"	**Periodic**	**SI**	**Table 1705A.2.1 Item 5a.5.** Per AISC 360-10 (and AISC 341-10 as applicable). DSA IR 17-3.
+	**WOOD**			
+	**OTHER**			

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List of required verified report(s):

1 Field Welding Inspection: Laboratory Verified Report - Form DSA-291, or, for independently contracting SI, Special Inspection Verified Report - Form DSA-292

KEY to Columns	
1 Type -	**2 Performed By -**
Continuous – Indicates that a continuous special inspection is required	**GE** – Indicates that the special inspection is to be performed by a registered geotechnical engineer or his or her authorized representative
Periodic – Indicates that a periodic special inspection is required	**LOR** – Indicates that the test or inspection is to be performed by a testing laboratory accepted in the DSA Laboratory Evaluation and Acceptance (LEA) Program. See section 4-335, 2013 CCR Title 24, Part 1.
Test – Indicates that a test is required	**SI** – Indicates that the special inspection is to be performed by a special inspector
COMPILE PRINT	

Name of Architect or Engineer in general responsible charge

ALDRIN ORUE

Name of Structural Engineer (When structural design has been delegated)

Signature of Architect or Structural Engineer

08/22/2017

date

REGISTERED PROFESSIONAL ENGINEER
ALDRIN J. ORUE
No. 4399
Exp. 12-31-19
STRUCTURAL
STATE OF CALIFORNIA

IDENTIFICATION STAMP
DIV OF THE STATE ARCHITECT
APP. # 3-118364
AC N/A F/LS N/A SS VC
DATE FEB 07 2018

Appendix: Work Exempt from DSA Requirements for Special Inspection or Structural Testing

DSA-103
(Issued 12-30-16)

+ In the CODE REFERENCE AND NOTES column indicates DSA-SS/CC sections that may be used by community colleges, per 2013~~6~~ CBC Sec. 1.9.2.2.

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Exempt items given in IR A-22 or the 2016 CBC (including DSA amendments) and those items identified below with an "X" by the design professional are NOT subject to DSA requirements for the structural tests and special inspections noted. The project inspector shall verify all construction complies with the approved construction documents.

Exempted by Design Prof.	Soils:
X	1. Deep foundations acting as a cantilever footing designed based on minimum allowable pressures per 2016 CBC Table 1806A.2 and having no geotechnical report for the following types of structures: free standing sign, scrolling message sign, scoreboard, covered walkway or shade structure with dead load less than 5 psf and other light-weight structures of which the apex is less than 8' above the highest adjacent grade.
X	2. Shallow foundations meeting the exception item #1 criteria specified in 2016 CBC Section 1803A.2.
(Optional) List details for applicable exempt items:	
	Concrete/Masonry:
X	1. Post-installed anchors for the following: 1) exempt non-structural components (e.g., mechanical, electrical, plumbing equipment) given in ASCE 7-10, Section 13.1.4 (and modified by CBC Section 1616A.1.18) or 2) interior nonstructural wall partitions meeting criteria listed in exempt item 3 for "Welding."
X	2. Concrete batch plant inspection is not required for items given in CBC Section 1705A.3.3.2 subject to the requirements and limitations in that section. Exempt retaining walls shall be less than 4'-0" above the top of foundation not supporting a surcharge and free standing nonbearing non-shear walls up to 6'-0" above adjacent grade.
X	3. Masonry retaining walls less than 4'-0" above the top of foundation not supporting a surcharge and free standing nonbearing non-shear masonry walls up to 6'-0" above adjacent grade do not require mortar or masonry core testing or DSA special inspection.
X	4. Epoxy shear dowels in site flatwork.

Exempted by Design Prof.	Welding:
X	1. Solid-clad and open-mesh gates with maximum leaf span or rolling section for rolling gates of 10' and apex height less than 8'-0" above lowest adjacent grade. When located above circulation or occupied space below, these gates are not located within 1.5x gate/fence height (max 8'-0") to the edge of floor or roof.
X	2. Handrails, guardrails, and modular or relocatable ramps associated with walking surfaces less than 30" above adjacent grade (excluding post base connections per the 'Exception' language in Section 1705A.2.1); fillet welds cannot be ground flush.
X	3. Non-structural interior cold-formed steel framing spanning less than 15'-0", such as in interior partitions, interior soffits, etc. supporting only self weight and light-weight finishes or adhered tile, masonry, stone, or terra cotta veneer no more than 5/8" thickness and apex less than 20'-0" in height and not over an exit way. Maximum tributary load to a member shall not exceed the equivalent of that occurring from a 10'x10' opening in a 15' tall wall for a header or king stud.
X	4. Manufactured support frames and curbs using hot rolled or cold-formed steel (i.e., light gauge) for mechanical, electrical, or plumbing equipment weighing less than 2000# (equipment only) (connections of such frames to superstructure elements using welding will require special inspection as noted in selected item(s) for section 19, 19.1 and/or 19.2 of listing above).
X	5. Manufactured components (e.g., Tolco, B-Line, Afcon, etc.) for mechanical, electrical, or plumbing hanger support and bracing (connections of such components to superstructure elements using welding will require special inspection as noted in selected item(s) for section 19, 19.1 and/or 19.2 of listing above).
X	6. TV Brackets, projector mounts with a valid listing (see DSA IR A-5) and recreational equipment (e.g., playground structures, basketball backstops, etc.) (connections of such elements to superstructure elements using welding will require special inspection as noted in selected item(s) for section 19, 19.1 and/or 19.2 of listing above).
X	7. Any support for exempt non-structural components given in ASCE 7-10, Section 13.1.4 (and modified by CBC Section 1616A.1.18) meeting the following: 1) when supported on a floor/roof, <400# and resulting composite center of mass (including component's center of mass) <= 4' above supporting floor/roof, 2) when hung from a wall or roof/floor, <20# for discrete units or <5 plf for distributed systems.
(Optional) List details for applicable exempt items:	

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(Optional) List details for applicable exempt items:

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JOHN MUIR ELEMENTARY SCHOOL- PROP 39 CHILLER UPGRADE

APPLICABLE CODES:

PARTIAL LIST OF APPLICABLE CODES AS OF JANUARY 1, 2017

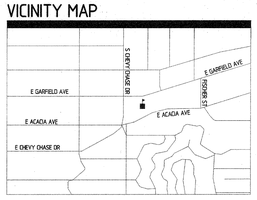
PART 1	2016 CALIFORNIA BUILDING STANDARD ADMINISTRATIVE CODE, TITLE 24 C.C.R.	
PART 2	2016 CALIFORNIA BUILDING CODE, TITLE 24 C.C.R. (2015 INTERNATIONAL BUILDING CODE OF THE INTERNATIONAL CODE COUNCIL, WITH CALIFORNIA AMENDMENTS)	
PART 3	2016 CALIFORNIA ELECTRICAL CODE, TITLE 24 C.C.R. (2014 NATIONAL ELECTRICAL CODE OF THE NATIONAL FIRE PROTECTION ASSOCIATION, NFPA)	
PART 4	2016 CALIFORNIA MECHANICAL CODE, TITLE 24 C.C.R. (2015 UNIFORM MECHANICAL OF THE INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS, IAPMO)	
PART 5	2016 CALIFORNIA PLUMBING CODE TITLE 24 C.C.R. (2015 UNIFORM MECHANICAL OF THE INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS, IAPMO)	
PART 6	2016 CALIFORNIA ENERGY CODE, TITLE 24 C.C.R.	
PART 8	2016 CALIFORNIA HISTORICAL BUILDING CODE, TITLE 24 C.C.R.	
PART 9	2016 CALIFORNIA FIRE CODE, TITLE 24 C.C.R. (2015 INTERNATIONAL FIRE CODE OF THE INTERNATIONAL CODE COUNCIL)	
PART 10	2016 CALIFORNIA EXISTING BUILDING CODE, TITLE 24 C.C.R. (2015 INTERNATIONAL EXISTING BUILDING CODE OF THE INTERNATIONAL CODE COUNCIL WITH AMENDMENTS)	
PART 12	2016 CALIFORNIA REFERENCED STANDARDS CODE, TITLE 24 C.C.R.	

PARTIAL LIST OF APPLICABLE STANDARDS:

2016 CALIFORNIA BUILDING CODE (for SFM) REFERENCED STANDARDS CHAPTER 35

NFPA 13	AUTOMATIC SPRINKLER SYSTEMS (CALIFORNIA AMENDED)	2016 EDITION
NFPA 14	STANDPIPES SYSTEMS (CALIFORNIA AMENDED)	2013 EDITION
NFPA 72	NATIONAL FIRE ALARM CODE (CALIFORNIA AMENDED) (NOTE SEE UL STANDARD 1971 FOR "VISUAL DEVICES")	2016 EDITION

VICINITY MAP



SCOPE OF WORK

WORK CONSISTS OF:
1. REPLACEMENT OF (E) CHILLER UNIT AT (E) CLASSROOM BUILDING 2/A CHILLER YARD A#51029

DIRECTORY

OWNER:	GLENDALE UNIFIED SCHOOL DISTRICT 223 N. JACKSON ST. GLENDALE, CA 91206
ARCHITECT:	NAC 837 N. SPRING STREET, THIRD FLOOR LOS ANGELES CA 90012
STRCTURAL ENGINEER:	KPFF CONSULTING ENGINEERS 301 N. LAKE AVENUE, SUITE 550 PASADENA CALIFORNIA 91101
MECHANICAL ENGINEER:	POCOCK DESIGN SOLUTIONS, INC 14451 CHAMBERS RD #210 TUSTIN, CA 92780
ELECTRICAL ENGINEER:	TURPIN & RATTAN ENGINEERING, INC 2441 HONOLULU AVE #200 MONTROSE, CA 91020

BUILDING DATA

CONSTRUCTION TYPE

BUILDING 2 TYPE - V (E-1) SPRINKLERED
WOOD FLOORS, ROOF, WITH MASONRY WALLS
FIREPROOFED STEEL ROOF FRAMING : TABLE 601
FIRE RESISTANCE REQUIREMENTS FOR BUILDING ELEMENTS: TABLE 601
*NOTE: FIRE SPRINKLERS DO NOT REDUCE FIRE RATING IF BEING USED FOR AREA OR HEIGHT INCREASE PER CBC TABLE 601 NOTE D

PRIMARY STRUCTURAL FRAME:	V
BEARING WALLS:	EXTERIOR 1 &INTERIOR1
NON-BEARING WALLS AND PARTITIONS:	EXTERIOR SEE CBC TABLE 602
NON-BEARING WALLS AND PARTITIONS:	INTERIOR 0
FLOOR CONSTRUCTION AND SECONDARY MEMBERS:	V
ROOF CONSTRUCTION AND SECONDARY MEMBERS:	V

FROM APPROVED A#51029
Code 1979 EDITION OF THE UNIFORM BUILDING CODE (UBC) AS ADOPTED BY THE OFFICE OF STATE ARCHITECT, ANS 1985 EDITION OF THE UNIFORM BUILDING CODEAS ADOPTED BY THE STATE FIRE MARSHAL, APPLICABLE SECTIONS OF THE CALIFORNIA ADMINISTRATIVE CODE, TITLE19,21, AND 24 AND ALL OTHER LOCAL CODES AND ORDINCANCES.

ZONE: C-1
OCCUPANCY: E-1
TYPE OF CONSTRUCTION, V-1 HR RATED
BUILDING HEIGHT: 32 FEET
AUTOMATIC FIRE SPRINKLER SYSTEM

OCCUPANT LOADS : GROUND FLOOR = 460
SECOND FLOOR = 477
TOTAL = 937

GROSE FLOOR AREA NEW BUILDING
GROUND FLOOR = 19,442 S.F.
SECOND FLOOR = 17,178 S.F.
TOTAL = 36,620 S.F.

ALLOWABLE AREA:

BASIC ALLOWABLE FLOOR AREA
E-1 (1-HR) GROUND FLOOR = 15,700 S.F.
INCREASE FOR SEP. OM 3 SIDES 10,990 S.F.
25% X 25 X 15700 S.F.=

TOTAL= 26,690 S.F > 19,442 S.F.

SHEET INDEX

STATEMENT OF GENERAL CONFORMANCE

FOR ARCHITECTS/ENGINEERS WHO UTILIZE PLANS, INCLUDING BUT NOT LIMITED TO SHOP DRAWINGS, PREPARED BY OTHER LICESNSED DESIGN PROFESSIONALS AND/OR CONSULTANTS (APPLICATION NO. A#03-118364 FILE NO. 19-41)

☒ THE DRAWINGS OR SHEETS LISTED ON THE COVER, UNDER THE SHEET INDEX, EXCLUDING G0.01, G0.02, & A1.01
☐ THIS DRAWING, PAGE OF SPECIFICATIONS/CALCULATIONS

HAVE BEEN PREPARED BY OTHER DESIGN PROFESSIONALS OR CONSULTANTS WHO ARE LICENSED AND/OR AUTHORIZED TO PREPARE SUCH DRAWINGS IN THIS STATE. IT HAS BEEN EXAMINED BY ME FOR:

1. DESIGN INTENT AND APPEARS TO MEET THE APPROPRIATE REQUIREMENTS OF TITLE 24, CALIFORNIA CODE OF REGULATIONS AND THE PROJECT SPECIFICATIONS PREPARED BY ME, AND
2. COORDINATION WITH MY PLANS AND SPECIFICATIONS AND IS ACCEPTABLE FOR INCORPORATION INTO THE CONSTRUCTION OF THIS PROJECT.

THE STATEMENT OF GENERAL CONFORMANCE "SHALL NOT BE CONSTRUED AS RELIEVING ME OF MY RIGHTS, DUTIES, AND RESPONSIBILITIES UNDER SECTIONS 17302 AND 81138 OF THE EDUCATION CODE AND SECTIONS 4-336, 4-341, AND 4-344" OF TITLE 24, PART 1 (TITLE 24, PART 1, SECTION 4-317(b))

I FIND THAT:
☒ ALL DRAWINGS OR SHEETS LISTED ON THE COVER OR INDEX
☐ SHEET THIS DRAWING OR PAGE

☒ IS/ARE IN GENERAL CONFORMANCE WITH THE PROJECT DESIGN, AND
☒ HAS/HAVE BEEN COORDINATED WITH THE PROJECT PLANS AND SPECIFICATIONS.

SIGNATURE DATE 02/05/18
ARCHITECT OR ENGINEER DESIGNATED TO BE IN GENERAL RESPONSIBLE CHARGE
TIMOTHY A. BALLARD
PRINT NAME
C 21424 08 / 31 / 19
LICENSE NUMBER EXPIRATION DATE

☐ IS/ARE IN GENERAL CONFORMANCE WITH THE PROJECT DESIGN, AND
☐ HAS/HAVE BEEN COORDINATED WITH THE PROJECT PLANS AND SPECIFICATIONS.

SIGNATURE DATE
ARCHITECT OR ENGINEER DELEGATED RESPONSIBILITY FOR THIS PORTION OF THE WORK
PRINT NAME
LICENSE NUMBER EXPIRATION DATE

GENERAL NOTES

1. ALL TESTS SHALL BE PERFORMED BY A LABORATORY CERTIFIED BY THE DIVISION OF THE STATE ARCHITECT EMPLOYED BY THE SCHOOL DISTRICT (OWNER).
2. A DIVISION OF THE STATE ARCHITECT APPROVED CLASS I IN PLANT INSPECTOR AND A DSA APPROVED CLASS 2 PROJECT INSPECTOR EMPLOYED BY THE DISTRICT (OWNER) SHALL PROVIDE CONTINUOUS INSPECTION FOR THE WORK. THE DUTIES OF THE INSPECTOR ARE DEFINED IN SECTION 4-342 PART-1 TITLE 24, CCR.
3. CHANGES TO THE APPROVED DRAWINGS AND SPECIFICATIONS SHALL BE MADE BY ADDENDA OR CONSTRUCTION CHANGE DIRECTIVE (CCD) APPROVED BY THE DIVISION OF THE STATE ARCHITECT, AS REQUIRED BY SECTION 4-338, PART 1, TITLE 24, CCR.
4. ALL TESTS SHALL CONFORM TO THE LATEST EDITION OF CALIFORNIA CODE OF REGULATIONS, TITLE 24 AND C.B.C. 2016.
5. GENERAL CONTRACTOR SHALL VISIT THE SITE BEFORE BIDDING THIS PROJECT. ANY DISCREPANCIES BETWEEN THE CONSTRUCTION DOCUMENTS AND SITE OBSERVATIONS SHALL BE BROUGHT TO THE ARCHITECTS ATTENTION IMMEDIATELY, IN WRITTEN FORM & SHALL TAKE THESE INTO CONSIDERATION IN THE COST OF THE BID. CONTRACTOR SHALL NOTIFY THE ARCHITECT WITH ANY CONDITIONS REQUIRING MODIFICATION BEFORE PROCEEDING WITH THE WORK.
6. SHOP DRAWINGS SHALL BE SUBMITTED FOR ALL NEW WORK. SHOP DRAWINGS SHALL BE OF A SCALE WHICH SPECIFIC COMPONENTS CAN BE IDENTIFIED.
7. CONSTRUCTION DOCUMENTS ARE DIAGRAMMATIC. DO NOT SCALE DIMENSIONS OFF THE DRAWINGS. FIELD VERIFY ALL DIMENSIONS. EACH CONTRACTOR SHALL CONSULT WITH CONSTRUCTION MANAGER REGARDING SCHEDULING OF WORK. EACH CONTRACTOR SHALL SUBMIT CONSTRUCTION SCHEDULE TO THE C.M. FOR APPROVAL BEFORE START OF CONSTRUCTION.
9. GENERAL CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES TO PROTECT EXISTING PIPELINES AND UTILITIES THAT ARE TO REMAIN IN SERVICE. EACH CONTRACTOR SHALL VERIFY WITH THE CONSTRUCTION MANAGER THAT THOSE PIPELINES AND UTILITIES THAT ARE TO BE REMOVED, HAVE BEEN DISCONNECTED, SHUT DOWN OR ABANDONED PRIOR TO ATTEMPTING REMOVAL OR DEMOLITION IN A MANNER TO AVOID ANY DISRUPTION OF EXISTING FACILITIES.
10. ALL DAMAGE DONE TO EXISTING CONSTRUCTION AS A RESULT OF DEMOLITION OR INSTALLATION SHALL BE COMPLETELY REPAIRED BY EACH CONTRACTOR AT NO COST TO OWNER. REPAIRED WORK SHALL MATCH EXISTING CONSTRUCTION.
11. PRODUCTS OF DEMOLITION/CONSTRUCTION SHALL BE STORED AND/OR INSTALLED IN A MANNER SUCH THAT NO MATERIALS ARE DAMAGED AND PUBLIC SAFETY IS MAINTAINED.
12. GENERAL CONTRACTOR SHALL THOROUGHLY CLEAN AND SECURE THE AREA OF CONSTRUCTION AFTER EACH DAY OF WORK.
13. GENERAL CONTRACTOR SHALL COORDINATE ALL WORK SHOWN ON THE ARCHITECT'S DRAWINGS WITH THE WORK SHOWN ON THE STRUCTURAL PLUMBING AND ELECTRICAL DRAWINGS. ANY DISCREPANCIES FOUND SHALL BE BROUGHT TO THE ARCHITECTS ATTENTION BY RFI'S (REQUEST FOR INFORMATION) BEFORE ANY NEW WORK IS STARTED
14. SHUT DOWN OF EXISTING AND OPERATING PLUMBING AND ELECTRICAL SYSTEMS OR PORTIONS THEREOF SHALL BE COORDINATED WITH THE GENERAL CONTRACTOR & DISTRICT.
15. THE INTENT OF THESE DRAWINGS AND SPECIFICATIONS IS THAT THE WORK IS TO BE IN ACCORDANCE WITH TITLE 24, CALIFORNIA CODE OF REGULATIONS. SHOULD ANY EXISTING CONDITIONS SUCH AS DETERIORATION OR NONCOMPLYING CONSTRUCTION BE DISCOVERED WHICH IS NOT COVERED BY THE CONTRACT DOCUMENTS WHEREIN THE FINISHED WORK WILL NOT COMPLY WITH TITLE 24, CALIFORNIA CODE OF REGULATIONS,CONSTRUCTION CHANGE DOCUMENT (CCD), SHALL BE SUBMITTED TO AND APPROVED BY THE DIVISION OF THE STATE ARCHITECT BEFORE PROCEEDING WITH THE WORK.
16. PARKED VEHICLES SHALL NOT OBSTRUCT REQUIRED EXITS.
17. STOCKPILES OF DEBRIS AND OTHER CONSTRUCTION RELATED MATERIALS MUST BE PROTECTED FROM BEING TRANSPORTED FROM THE SITE BY THE FORCES OF WIND OR WATER
18. EXCESS OR WASTE CONCRETE MAY NOT BE WASHED INTO THE PUBLIC WAY OR ANY OTHER DRAINAGE SYSTEM. PROVISIONS SHALL BE MADE TO RETAIN CONCRETE WASTES ON SITE UNTIL THEY CAN BE DISPOSED OF AS SOLID WASTE.
19. TRASH AND CONSTRUCTION RELATED DEBRIS MUST BE DEPOSITED INTO A COVERED RECEPTACLE TO PREVENT CONTAMINATION OF RAINWATER AND DISPERSAL BY WIND.
20. THE GENERAL CONTRACTOR SHALL COORDINATE BETWEEN ALL TRADES TO PROVIDE BACKING PLATES FOR ANCHORING & ATTACHMENT OF ALL WALL MOUNTED FIXTURES, ETC.
21. DETAILS ARE REFERENCED FOR CONVENIENCE ONLY. DETAILS & NOTES SHALL APPLY IN ALL SIMILAR CASES, WHETHER OR NOT SPECIFICALLY REFERENCED.
23. WRITTEN DIMENSIONS TAKE PRECEDENCE OVER SCALE. DO NOT SCALE THE DRAWINGS. ALL WORK SHALL CONFORM TO TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR) THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS IN THE FIELD.
24. AN INSPECTOR WHO IS SPECIALLY QUALIFIED IN MECHANICAL AND ELECTRICAL WORK WILL BE REQUIRED FOR THIS PROJECT.
25. GRADING PLANS, DRAINAGE IMPROVEMENTS, ROAD AND ACCESS REQUIREMENTS AND ENVIRONMENTAL HEALTH CONSIDERATIONS SHALL COMPLY WITH ALL LOCAL ORDINANCES
27. ALL STUD DIMENSIONS ARE TO THE FACE OF STUD, UNLESS NOTED OTHERWISE.CONCRETE OR MASONRY WALLS ARE MEASURED TO THE FACE,UNLESS NOTED OTHERWISE.
28. ALL MATTERS OF COLOR,TEXTURE, DESIGN AND INTERPRETATION OF PLANS SHALL BE REFERRED BY THE CONTRACTOR TO THE OAR FOR RESOLUTION BY THE ARCHITECT.
30. ALL CONSTRUCTION DOCUMENTS ARE COMPLEMENTARY AND WHAT IS SPECIFIED BY ONE SHALL BE BINDING AS IF SPECIFIED BY ALL. ANY WORK SHOWN OR REFERRED TO ON CONSTRUCTION DOCUMENTS, WHETHER DRAWINGS OR SPECIFICATIONS, SHALL BE PROVIDED AS THOUGH IT WERE SHOWN IN ALL RELATED DOCUMENTS.
31. THE GENERAL CONDITIONS AND OWNER/ CONTRACTOR AGREEMENT SHALL CONTROL THE EXECUTION, CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS.
32. THERMOSTAT LOCATIONS ON MECHANICAL DRAWINGS ARE DIAGRAMMATIC. CONTRACTOR SHALL VERIFY ALL THERMOSTAT LOCATIONS WITH ARCHITECT.
33. GENERAL CONTRACTOR SHALL COORDINATE FOR THE INSTALLATION OF ALL NECESSARY BLOCKING, BACKING, FRAMING, HANGERS, OR OTHER SUPPORT FOR ALL FIXTURES, EQUIPMENT, CABINETRY, FURNISHINGS, AND ALL OTHER ITEMS REQUIRING THE SAME.
34. GENERAL CONTRACTOR SHALL INVESTIGATE AND VERIFY THAT ALL WALL, FLOOR, AND OTHER FINISHES ARE APPLIED ACCORDING TO THE MANUFACTURER'S SPECIFICATIONS.
35. THE ELECTRICAL CONTRACTOR SHALL PROVIDE ALL NECESSARY BACKBOARDS, ELECTRICAL OUTLETS, CONDUIT, AND ETC., AS REQUIRED BY THE OWNER'S TELEPHONE COMPANY,TO ACCOMMODATE THEIR INSTALLATION.
36. TELEPHONE AND ELECTRICAL OUTLETS ON THE OPPOSITE SIDES OF COMMON WALLS SHALL BE LOCATED IN SEPARATE STUD CAVITIES. NO BACK-TO-BACK OUTLETS SHALL BE ALLOWED. WHERE SPECIFIC DIMENSIONS CONTRADICT THIS NOTE, THE CONTRACTOR SHALL RELOCATE ONE OUTLET TO THE OPPOSITE SIDE OF THE STUD NEAREST THAT DIMENSION.
37. ALL ELECTRICAL, PHONE, MECHANICAL AND PLUMBING LINES SHALL BE CONCEALED UNLESS OTHERWISE NOTED.
38. GENERAL CONTRACTOR SHALL COORDINATE ALL WORK W/ THE CONSTRUCTION MANAGER & DISTRICT TO ASSURE THE CORRECT SEQUENCE METHODS & TIMES OF PERFORMANCE, ARRANGE THE WORK TO IMPOSE THE MINIMUM HARDSHIP ON THE OPERATION & USE OF THE EXISTING CAMPUS.
39. ALL CONSTRUCTION APPARATUS & ACTIVITIES SHALL BE LIMITED TO DESIGNATED AREAS. ALL WORK SHALL BE DONE IN A MANNER WHICH WILL NOT ENDANGER THE USERS OF THE EXISTING CAMPUS.
40. THERE SHALL NOT BE ANY TRESPASSING ON THE ADJOINING PROPERTY. NO MATERIALS SHALL BE STORED ON THE ADJOINING PROPERTY. THE CONSTRUCTION MANAGER & EACH PRIME CONTRACTOR ARE TO INSPECT ALL SIDEWALKS INCLUDING THE ADJOINING PROPERTY PRIOR TO COMMENCING WORK. ALL EXISTING DAMAGE SHALL BE NOTED AND AGREED TO BY ALL PARTIES. ANY DAMAGE TO THESE SIDEWALKS OR ADJOINING PROPERTY DURING THE CONSTRUCTION SHALL BE REPAIRED PRIOR TO COMPLETION.
41. FUELS, OILS, SOLVENTS AND OTHER TOXIC MATERIALS MUST BE STORED IN ACCORDANCE WITH THEIR LISTING AND ARE NOT TO CONTAMINATE THE SOIL AND SURFACE WATERS. ALL APPROVED STORAGE CONTAINERS ARE TO BE PROTECTED FROM WEATHER. SPILLS MUST BE CLEANED UP IMMEDIATELY AND DISPOSED OF IN A PROPER MANNER. SPILLS MAY NOT BE WASHED INTO THE DRAINAGE SYSTEM
42. THE CONTRACTOR SHALL CARE FOR ,AND HAVE CUSTODY & RESPONSIBILITY FOR SAFEGUARDING ALL OF THE OWNERS PROPERTY OF EVERY KIND WHETHER FIXED OR PORTABLE. FURNISH ALL FORMS OF SECURITY & PROTECTION NECESSARY TO PROTECT THE OWNERS PROPERTY REGARDLESS OF CAUSE. EACH CONTRACTOR SHALL REPAIR, REPLACE OR OTHERWISE ACCEPTABLY RESTORE OWNERS PROPERTY UNDER THE CONTRACTORS CARE.
43. ALL MATERIAL USED IN THIS PROJECT SHALL BE NEW AND OF A KIND & QUALITY REQUIRED BY CONSTRUCTION DOCUMENTS.
44. TRENCHES OR EXCAVATIONS 5 FEET OR MORE IN DEPTH INTO WHICH A PERSON IS REQUIRED TO DESCEND. REQUIRE A SEPARATE PERMIT FROM THE STATE OF CALIFORNIA, DIVISION OF INDUSTRIAL SAFETY.

GENERAL DEMOLITION/PATCH & REPAIR NOTES

1. ALL SURFACES DAMAGED OR ALTERED SHALL BE REPAIRED, PATCHED AND/OR RECONSTRUCTED TO MATCH THE ADJACENT SURFACES.
2. ALL EXISTING EQUIPMENT, FIXTURES, ETC. REMOVED BY THE WORK OF THIS CONTRACT ARE THE PROPERTY OF THE CONTRACTOR (UNLESS NOTED OTHERWISE) AND SHALL BE DISPOSED OF BY THE CONTRACTOR AT HIS EXPENSE.
3. "REMOVE" MEANS TO REMOVE THE ITEM COMPLETELY, INCLUDING ALL STRUCTURAL ATTACHMENTS, FRAMES, HARDWARE, ANCHORS, FITTINGS, SUPPORTS, & FOUNDATIONS. CAPPING, PIPING AND CONDUIT BEHIND FINISHED SURFACES. REMOVING WIRING BACK TO THE PANEL AND REPAIRING ALL DAMAGED AREAS.
4. REMOVE ALL ITEMS NOT SHOWN ON THE DEMOLITION PLANS WHICH INTERFERE WITH OR OBSTRUCT THE WORK OF THIS CONTRACT AND ARE NOT NECESSARY TO THE PROPER FUNCTIONING OF THE FACILITY.
5. EXECUTE WORK BY METHODS TO AVOID DAMAGE TO EXISTING ADJACENT WORK TO REMAIN AND WHICH WILL PROVIDE PROPER SURFACES TO RECEIVE PATCHING AND FINISHING.
6. PRODUCTS FOR PATCHING, EXTENDING, AND MATCHING:

A.A. PROVIDE SAME PRODUCT OR TYPES OF CONSTRUCTION AS THAT IN EXISTING STRUCTURE, AS NEEDED, TO PATCH, EXTEND OR MATCH EXISTING WORK.

A.B. GENERALLY CONTRACT DOCUMENTS WILL NOT DEFINE PRODUCTS OR STANDARDS OR WORKMANSHIP PRESENT IN EXISTING CONSTRUCTION. CONTRACTOR SHALL DETERMINE PRODUCTS BY INSPECTION AND ANY NECESSARY TESTING, AND WORKMANSHIP BY USE OF THE EXISTING AS A SAMPLE OF COMPARISON.

7. PATCH AND EXTEND EXISTING WORK USING SKILLED CRAFTSPERSONS WHO ARE CAPABLE OF MATCHING EXISTING QUALITY OF WORKMANSHIP. QUALITY OF PATCHED OR EXTENDED WORK SHALL NOT BE LESS THAN THAT SPECIFIED FOR NEW WORK.
8. PATCH OR REPLACE ANY PORTION OF AN EXISTING FINISHED SURFACE WHICH IS FOUND TO BE DAMAGED, LIFTED, DISCOLORED, OR SHOWS OTHER IMPERFECTIONS, WITH MATCHING MATERIAL.

A.A. PROVIDE ADEQUATE SUPPORT OF SUBSTRATE PRIOR TO PATCHING THE FINISH.

A.B. REFINISH PATCHED PORTIONS OF PAINTED OR COATED SURFACES IN A MANNER TO PRODUCE UNIFORM COLOR AND TEXTURE OVER ENTIRE SURFACE.

A.C. WHEN EXISTING SURFACE FINISH CANNOT BE MATCHED, REFINISH ENTIRE SURFACE TO NEAREST INTERSECTIONS.

A.D. WHEN FINISHED SURFACES ARE CUT IN SUCH A WAY THAT A SMOOTH TRANSITION WITH NEW WORK IS NOT POSSIBLE, TERMINATE EXISTING SURFACE IN NEAT MANNER ALONG A STRAIGHT LINE AT A NATURAL LINE OF DIVISION, AND PROVIDE TRIM APPROPRIATE TO FINISHED SURFACE.

9. MAINTAIN EXISTING UTILITIES TO REMAIN IN SERVICE AND PROTECT THEM AGAINST DAMAGE DURING DEMOLITION OPERATIONS.
10. DURING DEMOLITION, SAFETY PROVISIONS SHALL BE MAINTAINED PER CFC-CHAPTER 11 AND CBC CHAPTER 33.
11. SUITABLE FIRE HOSE, AS REQUIRED BY THE FIRE CHIEF, SHALL BE MAINTAINED AT THE DEMOLITION SITE.
12. DEMOLITION OPERATIONS INVOLVING CUTTING AND WELDING SHALL BE IN ACCORDANCE WITH ARTICLE 49 CFC.
13. COMBUSTIBLE WASTE MATERIAL, TRASH AND RUBBISH SHALL NOT BE BURNED AT THE DEMOLITION SITE, UNLESS APPROVED.
14. WATER SUPPLY, ACCESS ROUTE AND FIRE PROTECTION SYSTEM SHALL BE MAINTAINED DURING DEMOLITION.
15. ALL OPENINGS IN EXISTING WALLS, FLOORS, CEILING AND ROOFS, THAT ARE THE RESULT OF DEMOLITION TO REMOVE EXISTING SYSTEMS/COMPONENTS, ARE TO BE PATCHED AND REPAIRED TO MATCH EXISTING FINISHES.
16. CONTRACTOR TO PATCH AND REPAIR EXISTING WALLS, FLOORS, CEILING AND ROOFS TO MATCH EXISTING FINISHES WHERE CUTTING AND DEMOLITION IS REQUIRED TO INSTALL THE WORK.
17. WHERE MECHANICAL EQUIPMENT IS DEMOLISHED, DUCTWORK MAY BE ABANDONED IN PLACE WHERE IT WILL BE CONCEALED FROM VIEW IN IMPROVEMENT PLANS. IF ABANDONED DUCTWORK CONFLICTS WITH CEILING IMPROVEMENTS, THE DUCTWORK SHALL BE REMOVED.
18. WHERE MECHANICAL EQUIPMENT IS DEMOLISHED, REMOVE ASSOCIATED CONTROLS, ELECTRICAL PANELS, CONDUIT AND WIRING BACK TO THE PANEL. CAP TO CONCEAL BEHIND NEAREST, WALL, FLOOR OR CEILING AS REQUIRED. IDENTIFY REMOVED CIRCUITS ON THE PANEL AS "SPARE".
19. THE WORK OF THIS PROJECT INVOLVES ALTERATIONS OF THE EXISTING BUILDINGS TO ACHIEVE THE ARRANGEMENT INDICATED ON THE DRAWINGS. VISIT THE JOB SITE TO DETERMINE THE EXTENT OF WORK REQUIRED BY THE CONSTRUCTION ACTIVITIES. THE ARCHITECTURAL DRAWINGS SHOW THE IMPROVEMENTS. REVISE, REARRANGE, REROUTE OR REMOVE EXISTING CONDUIT, PIPING, WIRING AND RELATED APPURTENANCES AS REQUIRED TO ACCOMMODATE THE CHANGES AND ADDITIONS SHOWN TO PROVIDE CONTINUING SERVICES FOR THOSE EXISTING PORTIONS OF THE PROJECT WHICH ARE TO REMAIN IN OPERATION.
20. ALL PENETRATIONS THROUGH WALLS, FLOORS, CEILINGS AND ROOFS ARE TO BE SEALED WITH ACOUSTIC RESILIENT CAULK OR FIRE-STOPPED PER CBC SECTION 712 WHEN PENETRATION IS THROUGH FIRE-RATED WALL, FLOOR, CEILING OR ROOF.

CONSTRUCTION DOCUMENTS

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OFFICE OF REGULATION SERVICES
FILE NO. 19-41
APPL NO. 03-118364
AC FLS SS VC
DATE FEB 07 2018

GLENDALE UNIFIED SCHOOL DISTRICT
MUIR ELEMENTARY SCHOOL - CHILLER UPGRADE
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TITLE PAGE

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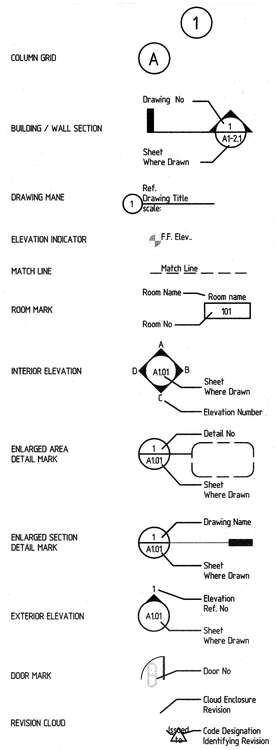
SYMBOLS



ABBREVIATIONS

@	AT	FLEX	FLEXIBLE	PL	PLATE, PROPERTY LINE
A.C.	ASPHALT CONCRETE	FLUOR	FLUORESCENT	PLBG	PLUMBING
A/C	ANCHOR BOLT	FO	FACE OF	PLAM	PLASTIC LAMINATE
ABC	AGGREGATE BASE COURSE	FP	FIREPROOF	PLF	POUNDS PER LINEAL FOOT
AC	ACOUSTICAL CEILING	F.S.	FINISH SLAB	PNL	PANEL
A.D.	ACCESS DOOR	FS	FIELD SURVEY	PO	POWER OPERATED
ADJ	ADJACENT	FR	FIRE RETARDANT	POT	PATH OF TRAVEL
				PR	PAIR
AFF	ABOVE FINISH FLOOR	FRP	FIBER REINF PLASTIC	PSF	POUNDS PER SQUARE FOOT
AGG	AGGREGATE	FT	FOOT, FEET	PSI	POUNDS PER SQUARE INCH
ALT	ALTERNATE	FTG	FOOTING	PT	POINT, PAINT
ALUM	ALUMINUM	FUR	FURRED(ING)	PTD	PAPER TOWEL DISPENSER
ANCH	ANCHOR, ANCHORAGE	FUT	FUTURE	PTR	PAPER TOWEL RECEPTOR
ANOD	ANODIZED			PVC	POLYVINYL CHLORIDE
		GA	GAGE (GAUGE)	PVMT	PAVEMENT
BD	BOARD	GALV	GALVANIZED	PWD	PLYWOOD
BFF	BELOW FINISH FLOOR	GC	GENERAL CONTRACTOR)		
BLDG	BUILDING	GD	GRADE	QTR	QUARTER
BLK(G)	BLOCKING)	GL	GLAZING	QTY	QUANTITY
BM	BENCH MARK	GWB	GYPSUM WALLBOARD		
BO	BOTTOM OF	GYP	GYPSUM	R	RECESSED
BOT	BOTTOM			(R)	RADIUS, RISER, ROUND
		HT)	HEIGHT	RA	RETURN AIR
BRG	BEARING	HB	HOSE BIBB	RB	RESILIENT BASE
BSMT	BASEMENT	HC	HOLLOW CORE	RCP	REFLECTED CEILING PLAN
BUR	BUILT UP ROOFING	HDBD	HARDBOARD	RD	ROOF DRAIN
		HD	HEAVY DUTY	REF)	REFERENCE
C	CHANNEL	HDWD	HARDWOOD	RELO	RELOCATION
C/C	CENTER TO CENTER	HDWR	HARDWARE	REPL	REPLACE
CAB	CABINET	HM	HOLLOW METAL	RES	RESILIENT
CB	CHALK BOARD, CATCH BASIN	HOR	HORIZONTAL	REV	REVISION(S),REVISED
CEM	CEMENT	HP	HIGH POINT	RF	RIGID FIBERGLASS
CG	CORNER GUARD	HR	HOUR	RFG	ROOFING
CI	CAST IRON	HVAC	HEATING/VENTILATING/	RH	RIGHT HAND
			AIR CONDITIONING	RM	ROOM
CIP	CAST IN PLACE	HW	HOT WATER	RO	ROUGH OPENING
CJ	CONTROL JOINT			ROW	RIGHT OF WAY
CL,CLK	CLOCK	ID	INSIDE DIAMETER	REQ'D	REQUIRED
CLG	CEILING, CHAIN LINK GATE	IE	INVERT ELEVATION	RWL	RAINWATER LEADER
CLR	CLEAR(ANCE)	IN	INCHES)		
CMP	CORRUGATED METAL PIPE	INCL	INCLUDING	S	SEALED, SOUTH
CMTS	COMMENTS	INSUL	INSULATION	(S)	SURFACE MOUNTED
		INT	INTERIOR	SC	SOLID CORE
CMU	CONCRETE MASONRY UNIT			SCHED	SCHEDULE
CO	CLEAN OUT	JC	JANITOR'S CLOSET	SECT	SECTION
COL	COLUMN	JT	JOINT	SD	STORM DRAIN
COMB	COMBINATION			SDG	SIDING
CONC	CONCRETE	KD	KNOCKED DOWN	SF	SQUARE FEET
CONN	CONNECTION	KP	KICK PLATE	SHT	SHEET
CONST	CONSTRUCTION			SHWR	SHOWER
		L	LENGTH LONG	SIM	SIMILAR
CONT	CONTINUOUS OR CONTINUE	LAB	LABORATORY	SM	SHEET METAL
CORR	CORRIDOR, CORRUGATED	LAM	LAMINATE	SMS	SHEET METAL SCREWS
CPT	CARPET	LAV	LAVATORY	SP	SOUNDPROOF
CSK	COUNTERSINK	LF	LINEAL FEET	SPECS	SPECIFICATIONS
CT	CERAMIC TILE	LH	LEFT HAND	SPKR	SPEAKER
CU FT	CUBIC FEET	LL	LIVE LOAD	SPL	SPECIAL
CW	COLD WATER	LLH	LONG LEG HORIZONTAL	SQ	SQUARE
		LLV	LONG LEG VERTICAL	SS	SERVICE SINK
D	DEPTH	LP	LOW POINT	S.S.	STAINLESS STEEL
DEMO	DEMOLISH, DEMOLITION	LTWT	LIGHT WEIGHT	ST	STREET
DF	DRINKING FOUNTAIN	LVR	LOUVER	STC	SOUND TRANSMISSION
DG	DECOMPOSED GRANITE				COEFFICIENT
DIA	DIAMETER	MAS	MASONRY	STD	STANDARD
DIAG	DIAGONAL	MAX	MAXIMUM	STL	STEEL
DIM	DIMENSION	MATL	MATERIAL	STOR	STORAGE
		MB	MARKER BOARD	STRUC	STRUCTURAL
DISP	DISPENSER	MED	MEDIUM	SUSP	SUSPENDED
DN	DOWN	MECH	MECHANICAL	SV	SEAMLESS VINYL
DO	DITTO	MET,MTL	METAL	SW	SWITCH
DP	DAMPPROOFING	MEZZ	MEZZANINE	SWR	SEWER
DR	DOOR	MNFR	MANUFACTURER	SYM	SYMMETRY(ICAL)
DS	DOWNSPOUT	MH	MAN HOLE		
DTL	DETAIL	MIN	MINIMUM	T	THICKNESS
		MISC	MISCELLANEOUS	TD	TRENCH DRAIN
DWG	DRAWING	MO	MASONRY OPENING	TB	TACK BOARD
DWC	DRYWALL CHANNEL	MOD	MODULAR	TEL	TELEPHONE
		MOV	MOVABLE	TEMP	TEMPERATURE,
(E)	EXISTING	MTD	MOUNTED		TEMPORARY
E	EAST	MWP	METAL WALL PANEL	THK	THICKNESS
EA	EACH			TO	TOP OF
EDF	ELECTRIC			TOC	TOP OF CONCRETE
EF	EACH FACE	(N)	NEW	TOIL	TOILET
EJ	EXPANSION JOINT	N	NORTH	TOP	TOP OF PARAPET
ELEC	ELECTRICAL	NA	NOT APPLICABLE	TOS	TOP OF STEEL
ELAST		NIC	NOT IN CONTRACT	TOW	TOP OF WALL
ELEV	ELEVATION, ELEVATOR	NOM	NOMINAL	TPD	TOILET PAPER DISPENSER
EMER	EMERGENCY	NRC	NOISE REDUCTION	TYP	TYPICAL
EP	EPOXY PAINT		COEFFICIENTS		
EPDM	ETHYLENE PROPYLENE	NTS	NOT TO SCALE	U	URINAL
EQ	EQUAL	NO	NUMBER	UG	UNDERGROUND
EQUIP	EQUIPMENT			UL	UNDERWRITERS LABORATORY
ES	EXPOSED STRUCTURE	OA	OVERALL	UNF	UNFINISHED
		OC	ON CENTER(S)	UNO	UNLESS NOTED OTHERWISE
EST	ESTIMATE	OD	OUTSIDE DIAMETER	VCT	VINYL COMPOSITION TILE
EW	EACH WAY	OFF	OFFICE	VERT	VERTICAL
EWC	ELECTRICAL WATER COOLER	OH	OVERHEAD, OPPOSITE HAND	VNR	VENEER
EXC	EXCAVATIE(IION)	OPG	OPENING	VPL	VENEER PLASTER
EXH	EXHAUST	OPP	OPPOSITE	VWC	VINYL WALL COVERING
EXIST	EXISTING	ORD	OVERFLOW ROOF DRAIN		
EXP	EXPANSION	OS	OUTSIDE	W	WIDTH
EXT	EXTERIOR			W/	WITH
		P.PNT	PIANTIED)	W/O	WITHOUT
F	FAHRENHEIT	PAR	PARALLEL	W/W	WALL TO WALL
FA	FIRE ALARM	PART	PARTITION	WC	WATER CLOSET
FAB	FABRICATE	PART BD	PARTICLE BOARD	WD	WOOD
FD	FLOOR DRAIN	PC	PIECE	WG	WIRE GLASS
FDN	FOUNDATION	PCC	PRECAST CONCRETE	WDW	WINDOW
FE	FIRE EXTINGUISHER	PCF	POUNDS PER CUBIC FOOT	WH	WALL HUNG, WATER HEATER
FEC	FIRE EXTINGUISHER CABINET	PERF	PERFORATE(D)	WM	WIRE MESH
		PERIM	PERIMETER	WP	WATERPROOFING
FF	FINISH FLOOR	PERP	PERPENDICULAR	WR	WATER REPELLENT
F.G.	FINISH GRADE	PH	PANIC HARDWARE	WS	WEATHER-STRIP
FHC	FIRE HOSE CABINET	PREFAB	PREFABRICATE(D)	WSCT	WAINSCOT
FHR	FIRE HOSE RACK	PJ	PANEL JOINT	WT	WEIGHT
FIN	FINISHED)	PJP	PARTIAL-JOINT	WWF	WELDED WIRE FABRIC
FJ	FALSE JOINT		PENETRATION		
FLA	FLASHING			YD	YARD

CONSTRUCTION DOCUMENTS

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APPL NO. 03-118364
AC FLS SS VC
DATE FEB 07 2018

GLENDALE UNIFIED SCHOOL DISTRICT
MUIR ELEMENTARY SCHOOL - CHILLER UPGRADE

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NAC NO	161-17036
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DATE	02-07-2018

SYMBOLS AND ABBREVIATIONS

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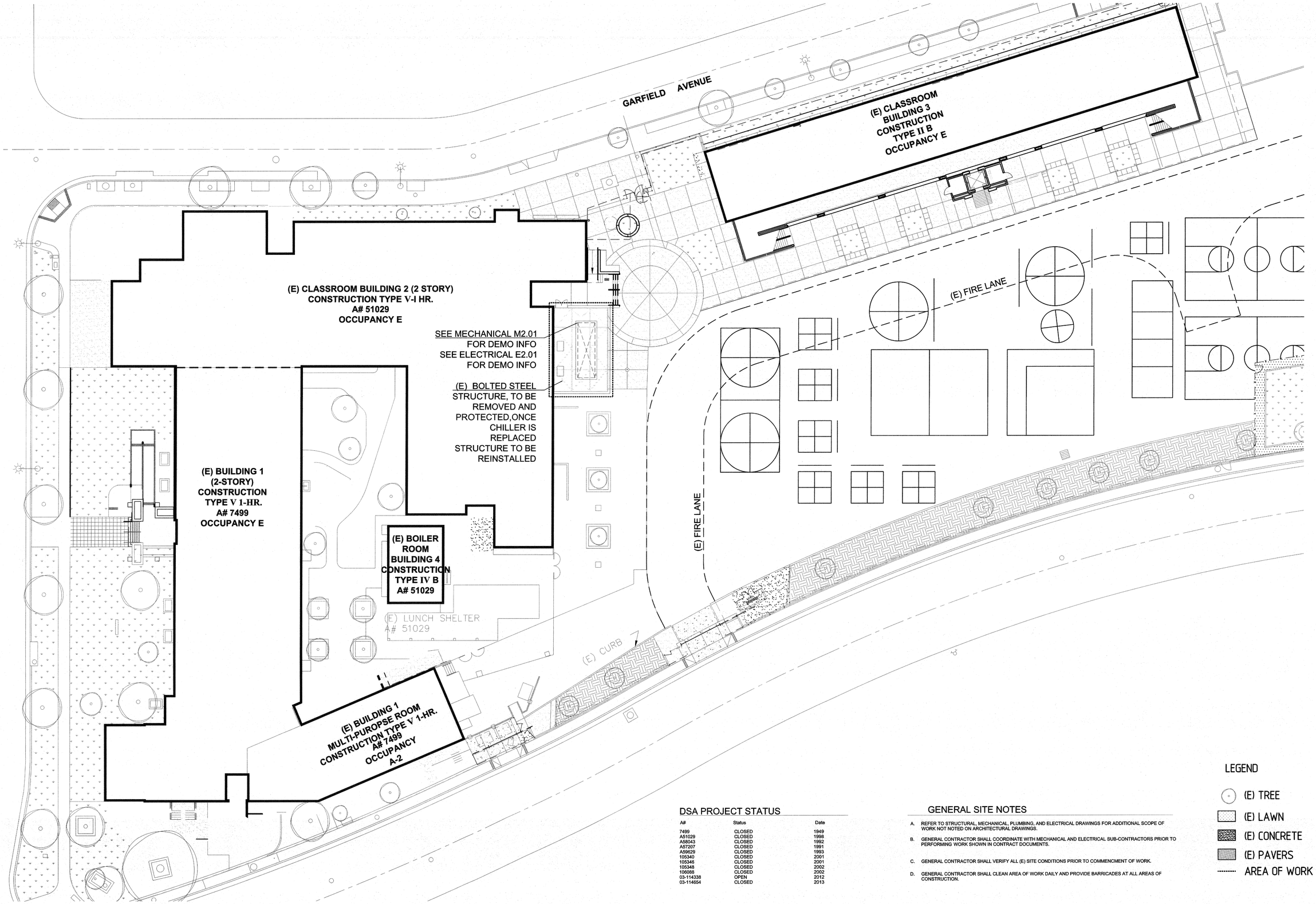

DSA PROJECT STATUS

A#	Status	Date
7499	CLOSED	1949
A51029	CLOSED	1998
A58043	CLOSED	1992
A57207	CLOSED	1991
A59629	CLOSED	1993
105340	CLOSED	2001
105346	CLOSED	2001
105348	CLOSED	2002
106088	CLOSED	2002
03-114338	OPEN	2012
03-114654	CLOSED	2013

GENERAL SITE NOTES

A. REFER TO STRUCTURAL, MECHANICAL, PLUMBING, AND ELECTRICAL DRAWINGS FOR ADDITIONAL SCOPE OF WORK NOT NOTED ON ARCHITECTURAL DRAWINGS.

B. GENERAL CONTRACTOR SHALL COORDINATE WITH MECHANICAL AND ELECTRICAL SUB-CONTRACTORS PRIOR TO PERFORMING WORK SHOWN IN CONTRACT DOCUMENTS.

C. GENERAL CONTRACTOR SHALL VERIFY ALL (E) SITE CONDITIONS PRIOR TO COMMENCMENT OF WORK.

D. GENERAL CONTRACTOR SHALL CLEAN AREA OF WORK DAILY AND PROVIDE BARRICADES AT ALL AREAS OF CONSTRUCTION.

LEGEND

- (E) TREE
- (E) LAWN
- (E) CONCRETE
- (E) PAVERS
- AREA OF WORK

N

1 SITE PLAN
SCALE: 1/16" = 1'-0"

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KEY PLAN/ CODE PLAN / ENLARGED DEMO PLAN

A1.01

ABBREVIATIONS

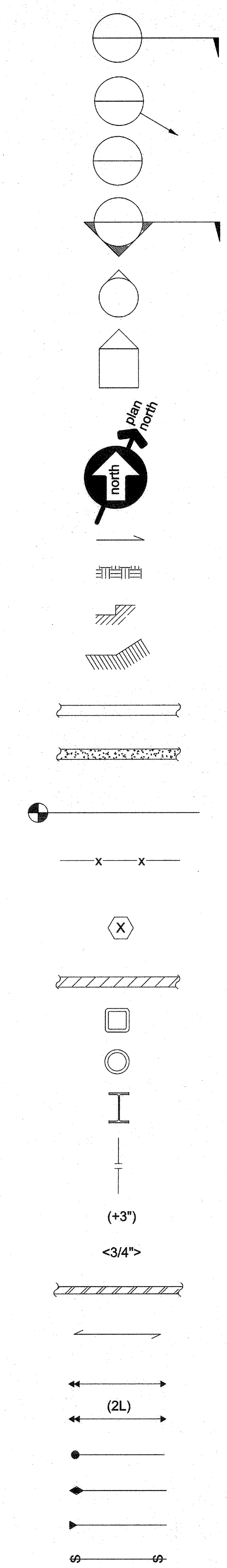
AB	ANCHOR BOLT
ACI	AMERICAN CONCRETE INSTITUTE
ADDL	ADDITIONAL
ADJ	ADJACENT
AESS	ARCHITECTURAL EXPOSED STRUCTURAL STEEL
AGGR	AGGREGATE
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
ALT	ALTERNATE
ALUM	ALUMINUM
ANCH	ANCHOR
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
APA	AMERICAN PLYWOOD ASSOCIATION
APPVD	APPROVED
APPROX	APPROXIMATE
ARCH	ARCHITECTURAL; ARCHITECT
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
AWPA	AMERICAN WOOD PRESERVERS ASSOCIATION
AWS	AMERICAN WELDING SOCIETY
AITC	AMERICAN INSTITUTE OF TIMBER CONSTRUCTION
ASTM	AMERICAN SOCIETY FOR TESTING MATERIALS
&	AND
@	AT
BLDG	BUILDING
BLK	BLOCK
BLKG	BLOCKING
BM	BEAM
BN	BOUNDARY NAIL
BNDRY	BOUNDARY
BOT OR	BOTTOM
BRC	BRACE
BRG	BEARING
BT	BENT
BTWN	BETWEEN
CANT	CANTILEVER
CAM OR	CAMBER
CC	CENTER TO CENTER
CRFM	CRUCIFORM
CG	CENTER OF GRAVITY
CIP	CAST-IN-PLACE
CJ	CONSTRUCTION JOINT; CONTROL JOINT
CL	CENTER LINE
CLR	CLEARANCE; CLEAR
CMU	CONCRETE MASONRY UNIT
COL	COLUMN
COMP	COMPRESSION
CONC	CONCRETE
CONN	CONNECTION; CONNECT
CONSTR	CONSTRUCTION
CONT	CONTINUE; CONTINUOUS
CONTR	CONTRACTOR
CJP	COMPLETE JOINT PENETRATION WELD
CTR	CENTER
CTSK	COUNTERSINK; COUNTERSUNK
CU FT	CUBIC FOOT
d	PENNY (NAIL OR BAR DIA)
DBL	DOUBLE
DEPT	DEPARTMENT
DET	DETAIL
DF	DOUGLAS FIR/LARCH
DIA OR Ø	DIAMETER
DIAG	DIAGONAL
DIAPH	DIAPHRAGM
DIM	DIMENSION
DN	DOWN
DO	DITTO (REPEAT)
DWG	DRAWING
DWL	DOWEL
EA	EACH
EF	EACH FACE
EJ	EXPANSION JOINT
EL	ELEVATION
ELEC	ELECTRICAL
ELEV	ELEVATOR
EMBED	EMBEDMENT
EN	EDGE NAIL
ENGR	ENGINEER
EQ	EQUAL OR EQUIVALENT
EQUIP	EQUIPMENT
ES	EACH SIDE
ETC	ET CETERA
EW	EACH WAY
EXIST or (E)	EXISTING
EXT	EXTERIOR
FDN	FOUNDATION
FF	FAR FACE
FF	FINISHED FLOOR
FIN	FINISH
FJ	FLOOR JOIST
FL	FLOOR LINE
FLG	FLANGE
FLR	FLOOR
FN	FIELD NAIL
FOC	FACE OF CONCRETE
FOM	FACE OF MASONARY
FOS	FACE OF STUD
FOW	FACE OF WALL
FP	FULL PENETRATION; FIRE PROOFING
FRMG	FRAMING
FS	FULL SIZE; FAR SIDE
FT	FOOT; FEET
FTG	FOOTING
GA	GAUGE
GALV	GALVANIZED
GB	GRADE BEAM
GLB	GLUED LAMINATED BEAM
GR	GRADE
GRND	GROUND
H or HORIZ	HORIZONTAL
HDR	HEADER
HGR	HANGER
HGT	HEIGHT
HOSP	HOSPITAL
HP	HIGH POINT
HS	HIGH STRENGTH
HSH	HORIZONTALLY SLOTTED HOLES
HT	HEIGHT
HR	HARD ROCK
ID	INSIDE DIAMETER
IF	INSIDE FACE
I-JST	I-JOIST
IN	INCH
INCL	INCLUDE
INFO	INFORMATION
INSP	INSPECTION
INT	INTERIOR
JST	JOIST
JT	JOINT
K	KIPS
KSI	KIPS PER SQUARE INCH

LAB	LABORATORY
LB(S) OR #	POUND(S)
LF	LINEAL FOOT
LIN	LINEAL; LINEAR
LLBB	LONG LEGS BACK-TO-BACK
LLH	LONG LEG HORIZONTAL
LLV	LONG LEG VERTICAL
LP	LOW POINT
LSL	LONG SLOTTED HOLES
LT WT	LIGHTWEIGHT
LVL	LEVEL
MAS	MASONRY
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MC	MISCELLANEOUS CHANNEL SHAPE
MECH	MECHANICAL
MFR	MANUFACTURER
MIN	MINIMUM; MINUTE
MISC	MISCELLANEOUS
(N)	NEW
N	NORTH
NF	NEAR FACE
NIC	NOT IN CONTRACT
NORM	NORMAL
NO or #	NUMBER
NS	NEAR SIDE
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OUTSIDE FACE
OH	OPPOSITE HAND
OPNG	OPENING
OPP	OPPOSITE
ORIG	ORIGINAL
OSB	ORIENTED STRAND BOARD
PARA OR //	PARALLEL
PC	PRECAST; PIECE
PERP	PERPENDICULAR
PI	PLYWOOD INDEX
℞	PLATE
PL	PROPERTY LINE
PLF	POUNDS PER LINEAL FOOT
PLCS	PLACES
PLY	PLYWOOD
PROP	PROPERTY
PT	POST TENSIONED
PW	PLATE WASHER
PJP	PARTIAL JOINT PENETRATION WELD
PREFAB	PREFABRICATED
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
PVMT	PAVEMENT
#	POUND; NUMBER
REF	REFERENCE
REINF	REINFORCE; REINFORCING
REQD	REQUIRED
RF	ROOF
RJ	ROOF JOIST
RW	RETAINING WALL
Ø	ROUND; DIAMETER
SCHED	SCHEDULE
SECT	SECTION
SEP	SEPERATION
SHT	SHEET
SHTG	SHEATHING
SIM	SIMILAR
SLBB	SHORT LEGS BACK-TO-BACK
SOG	SLAB ON GRADE
SN	SHEAR NAIL
SPCG	SPACING
SPECS	SPECIFICATIONS
SPCL	SPECIAL
SQ	SQUARE
SS	SELECT STRUCTURAL
SSL	SHORT SLOTTED HOLES
STAGG	STAGGER
STD	STANDARD
STGR	STAGGER
STIFF	STIFFENERS
STIRR	STIRRUP
STL	STEEL
STRUCT	STRUCTURAL
STRUCT I	STRUCTURAL I
SW	SHEAR WALL
SYM	SYMMETRICAL
TB	TIE BEAM
T & B	TOP AND BOTTOM
T & G	TONGUE & GROOVE
TO	TOP OF
TOC	TOP OF CURB; TOP OF CONCRETE
TOF	TOP OF FOOTING
TEMP	TEMPERATURE; TEMPORARY
THRU	THROUGH
THK	THICKNESS/THICK
THR	THREADED
TOP or T	TOP
TOS	TOP OF STEEL
TOW	TOP OF WALL
TSG	TAPPERED STEEL GIRDER
TYP	TYPICAL
UBC	UNIFORM BUILDING CODE
UNO	UNLESS NOTED OTHERWISE
UT	ULTRA-SONIC TEST
VERT	VERTICAL
VSH	VERTICAL SLOTTED HOLES
W	W SHAPE
W/	WITH
W/O	WITHOUT
WD	WOOD
WP	WORK POINT; WATERPROOF
WT	WEIGHT; STRUCTURAL TEE SHAPE
WWR	WELDED WIRE REINFORCEMENT

STRUCTURAL STEEL SHAPES

W	W SHAPE
C	AMERICAN STD CHANNEL SHAPE
MC	MISC CHANNEL SHAPE
L	ANGLE SHAPE
WT, ST, MT	STRUCT TEE SHAPE
PIPE	STANDARD PIPE SHAPE
PIPE-X	EXTRA STRONG PIPE SHAPE
PIPE-XX	DBL EXTRA STRONG PIPE SHAPE
HSS	STRUCT TUBING SHAPE

SYMBOLS



SECTION REFERENCE BUBBLE
DETAIL REFERENCE BUBBLE WITH ARROW
DETAIL REFERENCE BUBBLE
FULL HEIGHT SECTION INDICATOR
ELEVATION OF FRAME
ELEVATION OF WALL
NORTH ARROW
SLOPE
EARTH LAYER
STEPPED SURFACE; FLOOR DEPRESSION
SLOPPED SURFACE
INDICATES SAND OR GROUT
INDICATES GRAVEL
TOP OF SLAB ELEVATION
WELDED WIRE FABRIC (WWF LAYER)
FOOTING TYPE
INDICATES MASONRY WALLS
STEEL TUBE COLUMN
STEEL PIPE COLUMN
WIDE FLANGE STEEL COLUMN
MEMBER SPLICE
TOP OF STEEL ± ELEVATION
BEAM CAMBER AT MID-SPAN
STEEL IN CROSS SECTION
DIRECTION OF SPAN
ANGLE BRACE
DOUBLE ANGLE BRACE
DRAG STRUT CONNECTION
FULL HEIGHT STIFFENER CONNECTION
MOMENT CONNECTION
STEPPED FOOTING

SHEET LIST

S0.1	SHEET INDEX, ABBREVIATIONS & SYMBOLS
S0.2	STRUCTURAL GENERAL NOTES
S1.0	GROUND AND SECOND FLOOR FRAMING PLAN
S2.0	DETAILS

CONSTRUCTION DOCUMENTS

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SHEET INDEX, ABBREVIATIONS & SYMBOLS

S0.1

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Plotted: 2/2/18 at 11:00am By: ADrake

MECHANICAL CONCRETE ANCHORS

1. EXPANSION ANCHORS SHALL BE THE FOLLOWING, UNLESS NOTED OTHERWISE ON THE DRAWINGS
   a. HILTI KWIK BOLT TZ (ICC ESR-1917). STAINLESS STEEL ANCHORS REQUIRED AT EXTERIOR CONDITIONS.
   b. EQUAL WITH CURRENT ICC OR IAPMO TEST REPORT, APPROVED BY SEOR & DSA.
2. INSTALL ALL ANCHORS PER MANUFACTURER'S RECOMENDATIONS AND REQUIREMENTS OF THE CURRENT ICC OR IAPMO TEST REPORT.

STRUCTURAL STEEL

1. STRUCTURAL STEEL SHALL BE DETAILED, FABRICATED AND ERECTED BY AN APPROVED AND LICENSED FABRICATOR IN ACCORDANCE WITH THE AISC SPECIFICATION FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS (LATEST EDITION), AND WITH CHAPTER 22A OF THE CODE.
2. ALL STRUCTURAL STEEL SHALL CONFORM TO THE ASTM DESIGNATION AS INDICATED BELOW (UNO):

   PLATES, CONNECTION PLATES, AND MISC., U.N.O. A-36
3. THE STRUCTURAL STEEL FABRICATOR SHALL FURNISH SHOP DRAWINGS TO THE ARCHITECT OF ALL STEEL FOR ARCHITECTS AND STRUCTURAL ENGINEERS REVIEW AND APPROVAL BEFORE FABRICATION.
4. BOLT HOLES USED IN STEEL SHALL BE 1/16" LARGER IN DIAMETER THAN NORMAL SIZE OF BOLT USED, EXCEPT AS NOTED.
5. ALL STRUCTURAL STEEL SURFACES THAT ARE ENCASED IN CONCRETE, OR MASONRY, SPRAY ON FIREPROOFING, OR ARE ENCASED BY BUILDING FINISH, SHALL BE LEFT UNPAINTED.
6. ALL WELDING IS TO BE DONE BY CERTIFIED WELDERS USING E70XX ELECTRODES (UNO). ALL WELDS SHALL BE IN CONFORMITY WITH THE PROJECT SPECIFICATIONS AND THE CODE FOR WELDING IN BUILDING CONSTRUCTION (AWS D1.1 LATEST REVISION) OF THE AMERICAN WELDING SOCIETY. SEE SPECIAL INSPECTIONS SECTION FOR WELDING INSPECTION REQUIREMENTS.
7. WELD LENGTHS CALLED FOR ON PLANS ARE THE NET EFFECTIVE LENGTH REQUIRED. WHERE FILLET WELD SYMBOL IS GIVEN WITHOUT INDICATION OF SIZE, USE MINIMUM SIZE WELDS AS SPECIFIED IN AISC MANUAL OF STEEL CONSTRUCTION 9TH EDITION, SECTION J2.2B.
8. ALL STRUCTURAL STEEL AND MISCELLANEOUS METAL EXPOSED TO WEATHER SHALL BE HOT DIP GALVANIZED AFTER FABRICATION, THEN PRIMED AND PAINTED.
9. THE USE OF E70T-4 WELDING WIRE IS NOT PERMITTED.
10. ALL WELD FILLER MATERIAL SPECIFIED AS "NOTCH TOUGH" SHALL HAVE A MINIMUM CHARPY-V NOTCH (CVN) VALUE OF 20 FT-LBS AT A TEMPERATURE OF -20° F.
11. 100% UT TEST FOR ALL COMPLETE PENETRATION GROOVE WELDS.
12. DISCONTINUITIES IN WELD CREATED BY ERRORS OR BY FABRICATION OR ERECTION OPERATIONS, SUCH AS TACK WELDS, ERECTION AIDS, AIR ARC GOUGING AND FLAME CUTTING, SHALL BE REPAIRED AS REQUIRED BY THE ENGINEER OF RECORD.
13. WRITTEN WELDING PROCEDURE SPECIFICATIONS (WPS) PER THE RECOMMENDATIONS OF THE AMERICAN WELDING SOCIETY (AWS) SHALL BE DEVELOPED BY THE FABRICATOR/ERECTOR AND SUBMITTED FOR REVIEW TO THE ENGINEER PRIOIR TO ANY WELDING OF THE STRUCTURAL STEEL. THE WELDING PROCEDURES SHALL INCLUDE ALL THE WELDED JOINTS AND CONFIGURATIONS TO BE USED ON THIS PROJECT-ONLY WPS WHICH ARE RELEVANT TO THIS PROJECT SHALL BE SUBMITTED. ALL WELDED JOINTS SHALL BE PRE-QUALIFIED PER AWS OR BE QUALIFIED BY TEST PER AWS. A PROCEDURE QUALIFICATION RECORD (PQR) SHALL BE INCLUDED WITH THE WPS IF THE WELDING PROCEDURE OR JOINT IS QUALIFIED BY TESTING. THE ELECTRODE MANUFACTURER AND PRODUCT/TRADE NAME SHALL BE IDENTIFIED IN THE WPS IN ADDITION TO THE AWS ELECTRODE CLASSIFICATION NAME. A COPY OF THE ELECTRODE MANUFACTURER'S TECHNICAL DATA SHEETS WITH THE RECOMMENDED WELDING PARAMETERS SHALL BE SUBMITTED WITH THE WPS.

STRUCTURAL TESTS AND SPECIAL INSPECTIONS

1. STRUCTURAL TESTS AND SPECIAL INSPECTIONS SHALL BE PERFORMED IN ACCORDANCE WITH CHAPTER 17A OF THE 2016 CBC.
2. THE SPECIAL INSPECTOR MUST BE APPROVED BY DSA, IN THE CATEGORY OF WORK REQUIRED TO HAVE SPECIAL INSPECTION.
3. THE SPECIAL INSPECTORS AND TESTING FIRM MUST BE HIRED BY THE OWNER OR OWNER'S REPRESENTATIVE.
4. SPECIAL INSPECTORS SHALL SHALL KEEP RECORDS OF INSPECTIONS AND FURNISH COPIES TO THE BUILDING OFFICIAL, OWNER, AND STRUCTURAL ENGINEER OF RECORD. REPORTS SHALL INDICATE THAT WORK INSPECTED WAS, OR WAS NOT COMPLETED IN CONFORMANCE TO APPROVED CONSTRUCTION DOCUMENTS. SPECIAL INSPECTORS SHALL KEEP RECORDS OF INSPECTIONS AND FURNISH COPIES TO THE BUILDING OFFICIAL, COMPLETED IN CONFORMANCE WITH THE APPROVED CONSTRUCTION DOCUMENTS. DISCREPANCIES SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION.

REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION:

VERIFICATION AND INSPECTION	CONTINUOUS	PERIODIC	REFERENCED STANDARD	CBC REFERENCE
1. INSPECTION OF ANCHORS POST-INSTALLED IN HARDENED CONCRETE.	-	X	ACI 318:17.8.2.4 ACI 318:17.8.2	-

REQUIRED VERIFICATION AND INSPECTION OF STRUCTURAL STEEL CONSTRUCTION:

VERIFICATION AND INSPECTION	CONTINUOUS	PERIODIC	REFERENCED STANDARD	CBC REFERENCE
1. IDENTIFICATION OF STRUCTURAL STEEL MARKINGS TO CONFORM TO AISC 360	-	X	AISC 360, SECTION A3.1	2203A.1
2. STRUCTURAL STEEL MANUFACTURER'S CERTIFIED TEST REPORTS	-	X	-	-
3. REINSTALLATION OF (E) STEEL FRAMING AND CONNECTIONS	-	X	-	-

STRUCTURAL NOTES

GENERAL

1. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS PRIOR TO STARTING CONSTRUCTION. THE ARCHITECT SHALL BE NOTIFIED OF ANY DISCREPANCIES OR INCONSISTENCIES.
2. ALL DRAWINGS ARE CONSIDERED TO BE A PART OF THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE REVIEW AND COORDINATION OF ALL DRAWINGS AND SPECIFICATIONS PRIOR TO THE START OF CONSTRUCTION. ANY DISCREPANCIES THAT OCCUR SHALL BE BROUGHT TO THE ATTENTION OF THE ARCHITECT PRIOR TO START OF CONSTRUCTION SO THAT A CLARIFICATION CAN BE ISSUED. ANY WORK PERFORMED IN CONFLICT WITH THE CONTRACT DOCUMENTS OR ANY CODE REQUIREMENTS SHALL BE CORRECTED BY THE CONTRACTOR AT THEIR OWN EXPENSE AND AT NO EXPENSE TO THE OWNER OR ARCHITECT.
3. NOTES AND DETAILS ON DRAWINGS SHALL TAKE PRECEDENCE OVER GENERAL NOTES AND TYPICAL DETAILS. WHERE NO DETAILS ARE GIVEN, CONSTRUCTION SHALL BE AS SHOWN FOR SIMILAR WORK.
4. ALL WORK SHALL CONFORM TO THE MINIMUM STANDARDS OF THE FOLLOWING:

   2016 CALIFORNIA BUILDING CODE, VOLUME 2A, REFERRED TO HERE AS "THE CODE", AND ANY OTHER REGULATING AGENCIES WHICH HAVE AUTHORITY OVER WHICH ANY PORTION OF THE WORK, INCLUDING THE STATE OF CALIFORNIA DIVISION OF INDUSTRIAL SAFETY, AND THOSE CODES & STANDARDS LISTED IN THESE NOTES AND SPECIFICATIONS.
5. SEE ARCHITECTURAL DRAWINGS FOR THE FOLLOWING:
   a. SIZE AND LOCATION OF ALL DOOR AND WINDOW OPENINGS, EXCEPT AS NOTED
   b. SIZE AND LOCATION OF ALL INTERIOR AND EXTERIOR NON-BEARING PARTITIONS.
   c. SIZE AND LOCATION OF ALL CONCRETE CURBS, EQUIPMENT PADS, PITS, FLOOR DRAINS, SLOPES, DEPRESSED AREAS, CHANGE IN LEVEL, CHAMFERS, GROOVES, INSERTS, ETC.
   d. SIZE AND LOCATION OF ALL FLOOR AND ROOF OPENINGS EXCEPT AS SHOWN.
   e. FLOOR AND ROOF FINISHES.
   f. DIMENSIONS NOT SHOWN ON STRUCTURAL DRAWINGS.
6. SEE MECHANICAL, PLUMBING AND ELECTRICAL DRAWINGS FOR THE FOLLOWING:
   a. PIPE RUNS, SLEEVES, HANGERS, TRENCHES, WALL AND SLAB OPENINGS, ETC., EXCEPT AS SHOWN OR NOTED.
   b. ELECTRICAL CONDUIT RUNS, BOXES, OUTLETS IN WALLS AND SLABS.
   c. CONCRETE INSERTS FOR ELECTRICAL, MECHANICAL OR PLUMBING FIXTURES.
   d. SIZE AND LOCATION OF MACHINE OR EQUIPMENT BASES, ANCHOR BOLTS FOR MOTOR MOUNTS.
7. THE CONTRACT STRUCTURAL DRAWINGS AND SPECIFICATIONS REPRESENT THE FINISHED STRUCTURE. THEY DO NOT INDICATE THE METHOD OF CONSTRUCTION. THE CONTRACTOR SHALL PROVIDE ALL MEASURES NECESSARY TO PROTECT THE STRUCTURE DURING CONSTRUCTION. SUCH MEASURES SHALL INCLUDE, BUT NOT BE LIMITED TO, BRACING, SHORING FOR LOADS DUE TO CONSTRUCTION EQUIPMENT, ETC. OBSERVATION VISITS TO THE SITE BY THE STRUCTURAL ENGINEER SHALL NOT INCLUDE INSPECTION OF THE ABOVE ITEMS.
8. OPENINGS, POCKETS, ETC., LARGER THAN 6" SHALL NOT BE PLACED IN CONCRETE SLABS, DECKS, WALLS, UNLESS SPECIALLY DETAILED ON THE STRUCTURAL DRAWINGS. NOTIFY THE STRUCTURAL ENGINEER WHEN DRAWINGS BY OTHERS SHOW OPENINGS, POCKETS, ETC., LARGER THAN 6" NOT SHOWN ON THE STRUCTURAL DRAWINGS, BUT WHICH ARE LOCATED IN STRUCTURAL MEMBERS. FOR ANY FURTHER RESTRICTIONS ON OPENINGS IN STRUCTURAL ELEMENTS, SEE APPLICABLE SECTIONS BELOW.
9. PIPES SHALL NOT BE EMBEDDED IN STRUCTURAL CONCRETE.
10. ASTM SPECIFICATIONS ON THE DRAWINGS SHALL BE OF THE LATEST REVISION.
11. CONTRACTOR SHALL INVESTIGATE SITE DURING CLEARING AND EARTHWORK OPERATIONS FOR FILLED EXCAVATIONS OR BURIED STRUCTURES, SUCH AS CESSPOOLS, CISTERNS, FOUNDATIONS, ETC. IF ANY SUCH STRUCTURES ARE FOUND, STRUCTURAL ENGINEER SHALL BE NOTIFIED IMMEDIATELY.
12. CONSTRUCTION MATERIAL SHALL BE SPREAD OUT IF PLACED ON FRAMED ROOF OR FLOOR. LOAD SHALL NOT EXCEED THE DESIGN LIVE LOAD PER SQUARE FOOT. PROVIDE ADEQUATE SHORING AND/OR BRACING WHERE STRUCTURE HAS NOT ATTAINED DESIGN STRENGTH.

DESIGN LOADS

LOCATION: 34.1405, -118.2397

1. EARTHQUAKE LOADS ON NONSTRUCTURAL COMPONENTS:

   EARTHQUAKE LOADS ARE IN ACCORDANCE WITH SECTION 1613A OF THE CODE.

   S_S = 2.785g
   S_1 = 0.964g
   F_a = 1.0
   F_v = 1.5
   S_{MS} = 2.785g — RISK CATEGORY III
   S_{M1} = 1.446g — SITE CLASS D
   S_{DS} = 1.857g — SEISMIC DESIGN CATEGORY E
   S_{D1} = 0.964g

   I_e = 1.25
   rho = 1.0

   Ip = 1.0 FOR ALL NONSTRUCTURAL COMPONENTS EARTHQUAKE LOADS ON NONSTRUCTURAL COMPONENTS, SHALL BE DETERMINED IN ACCORDANCE WITH THE FOLLOWING PROCEDURE:

   CALCULATE Fp BASED ON ASCE 7-10 EQUATION 13.3-1 USING THE VALUE OF S_{DS}

   THE MAXIMUM AND MINIMUM VALUES FOR Fp SHALL BE DETERMINED FROM ASCE 7-10 EQUATIONS 13.3-2 AND 13.3-3, RESPECTIVELY.

   ALL EARTHQUAKE LOADS ON NONSTRUCTURAL COMPONENTS SHALL BE BASED ON THE VALUES OF ap AND Rp FROM ASCE 7-10 TABLES 13.5-1 AND 13.6-1.

2. WIND LOAD ON NON STRUCTURAL COMPONENTS

   WIND LOADS ARE IN ACCORDANCE WITH ASCE 7-10 CH 29 USING EQUATIONS 29.5-2 AND 29.3-1

   WIND SPEED, V = 115MPH
   RISK CATEGORY = III
   EXPOSURE CATEGORY = B
   WIND LOAD TO CHILLERS YARD UNITS = NOT APPLICABLE

3. SOIL BEARING

   MAX ALLOWABLE SOIL BEARING = 1500 PSF (CBC 2013 TABLE 1806A.2)

STRUCTURAL OBSERVATION:

1. STRUCTURAL OBSERVATION SHALL BE PERFORMED BY THE STRUCTURAL ENGINEER OF RECORD OR DESIGNEE IN ACCORDANCE WITH SECTION 1709A OF THE CODE.
2. STRUCTURAL OBSERVATION IS THE VISUAL OBSERVATION OF THE ELEMENTS AND CONNECTIONS OF THE STRUCTURAL SYSTEM AT SIGNIFICANT CONSTRUCTION STAGES AND THE COMPLETED STRUCTURE FOR GENERAL CONFORMANCE TO THE APPROVED PLANS AND SPECIFICATION. STRUCTURAL OBSERVATION DOES NOT WAIVE THE RESPONSIBILITY FOR THE INSPECTIONS REQUIRED OF THE BUILDING INSPECTOR OR THE DEPUTY INSPECTOR.
3. A CIVIL OR STRUCTURAL ENGINEER OR ARCHITECT SHALL PERFORM THE STRUCTURAL OBSERVATION THE ENGINEER OR ARCHITECT SHALL BE REGISTERED OR LICENSED IN THE STATE OF CALIFORNIA. THE DEPARTMENT OF BUILDING AND SAFETY RECOMMENDS THE USE OF THE ENGINEER OR ARCHITECT RESPONSIBLE FOR THE STRUCTURAL DESIGN WHEN THEY ARE INDEPENDENT OF THE CONTRACTOR.
4. THE STRUCTURAL OBSERVER SHALL PROVIDE EVIDENCE OF EMPLOYMENT BY THE OWNER, A LETTER FROM THE OWNER OR A COPY OF THE AGREEMENT FOR SERVICES SHALL BE SENT TO THE BUILDING INSPECTOR BEFORE THE FIRST SITE VISIT, THE STRUCTURAL OBSERVER SHALL ALSO INFORM THE OWNER OF THE REQUIREMENTS FOR A PRECONSTRUCTION MEETING AND SHALL PRESIDE OVER THIS MEETING.
5. THE CONTRACTOR SHALL COORDINATE AND CALL FOR A PRE-CONSTRUCTION MEETING BETWEEN THE ENGINEER OR ARCHITECT RESPONSIBLE FOR THE STRUCTURAL DESIGN, STRUCTURAL OBSERVER, CONTRACTOR, AFFECTED SUBCONTRACTORS AND DEPUTY INSPECTORS. THE PURPOSE OF THE MEETING SHALL BE TO IDENTIFY THE MAJOR STRUCTURAL ELEMENTS AND CONNECTIONS THAT AFFECT THE VERTICAL AND LATERAL LOAD SYSTEMS OF THE STRUCTURE AND TO REVIEW SCHEDULING OF THE REQUIRED OBSERVATIONS. A RECORD OF THE MEETING SHALL BE INCLUDED IN THE FIRST OBSERVATION REPORT SUBMITTED TO THE BUILDING INSPECTOR.
6. THE STRUCTURAL OBSERVER SHALL PERFORM SITE VISITS AT THOSE STEPS IN THE PROGRESS OF THE WORK THAT ALLOW FOR CORRECTION OF DEFICIENCIES WITHOUT SUBSTANTIAL EFFORT OR UNCOVERING OF THE WORK INVOLVED. AT A MINIMUM, THE FOLLOWING SIGNIFICANT CONSTRUCTION STAGES REQUIRE A SITE VISIT AND AN OBSERVATION REPORT FROM THE STRUCTURAL OBSERVER.

CONSTRUCTION STAGES	ELEMENTS/CONNECTIONS TO BE OBSERVED
a. EQUIPMENT ANCHORAGE	ANCHORS LAYOUT
b. STEEL FRAMING	REINSTALLED (E) FRAMING AND CONNECTIONS

7. THE STRUCTURAL OBSERVER SHALL PREPARE A REPORT FOR EACH SIGNIFICANT STATE OF CONSTRUCTION OBSERVED. A COPY OF THE OBSERVATION REPORT SHALL BE SENT TO OWNER, CONTRACTOR, AND PROJECT INSPECTOR.

CONSTRUCTION DOCUMENTS

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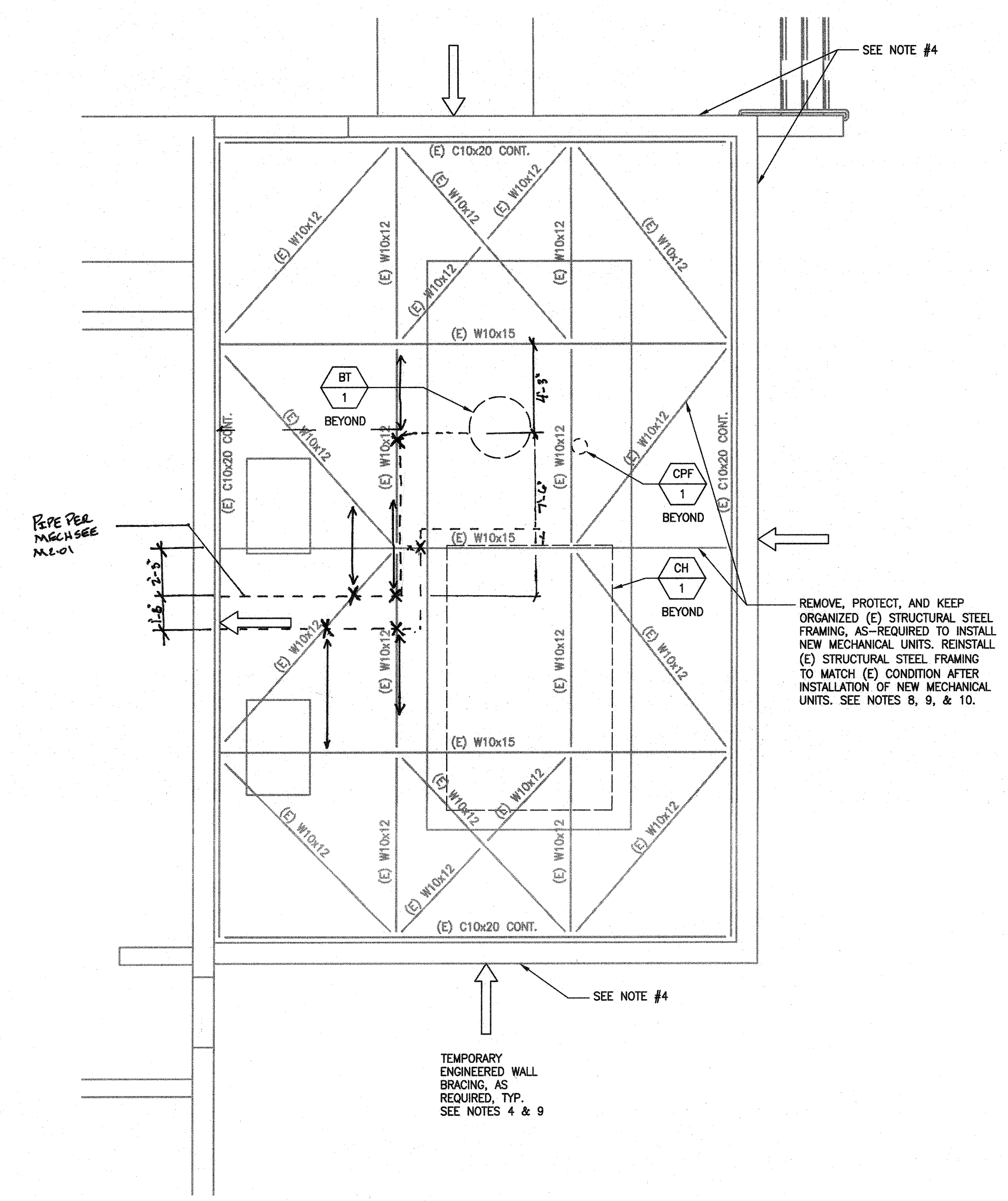
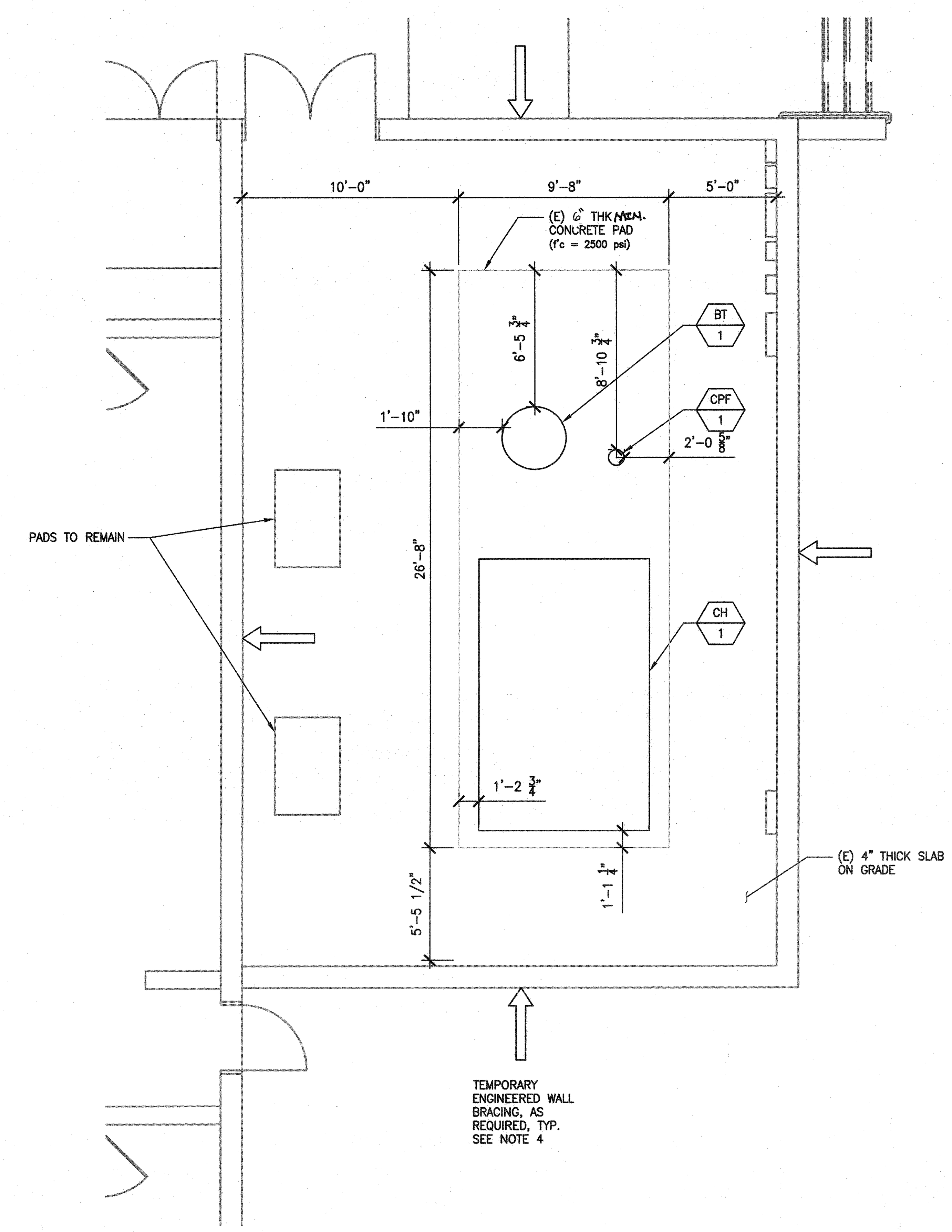
STRUCTURAL GENERAL NOTES

S0.2



2 2nd FLOOR FRAMING PLAN
SCALE = 1/4"=1'-0"

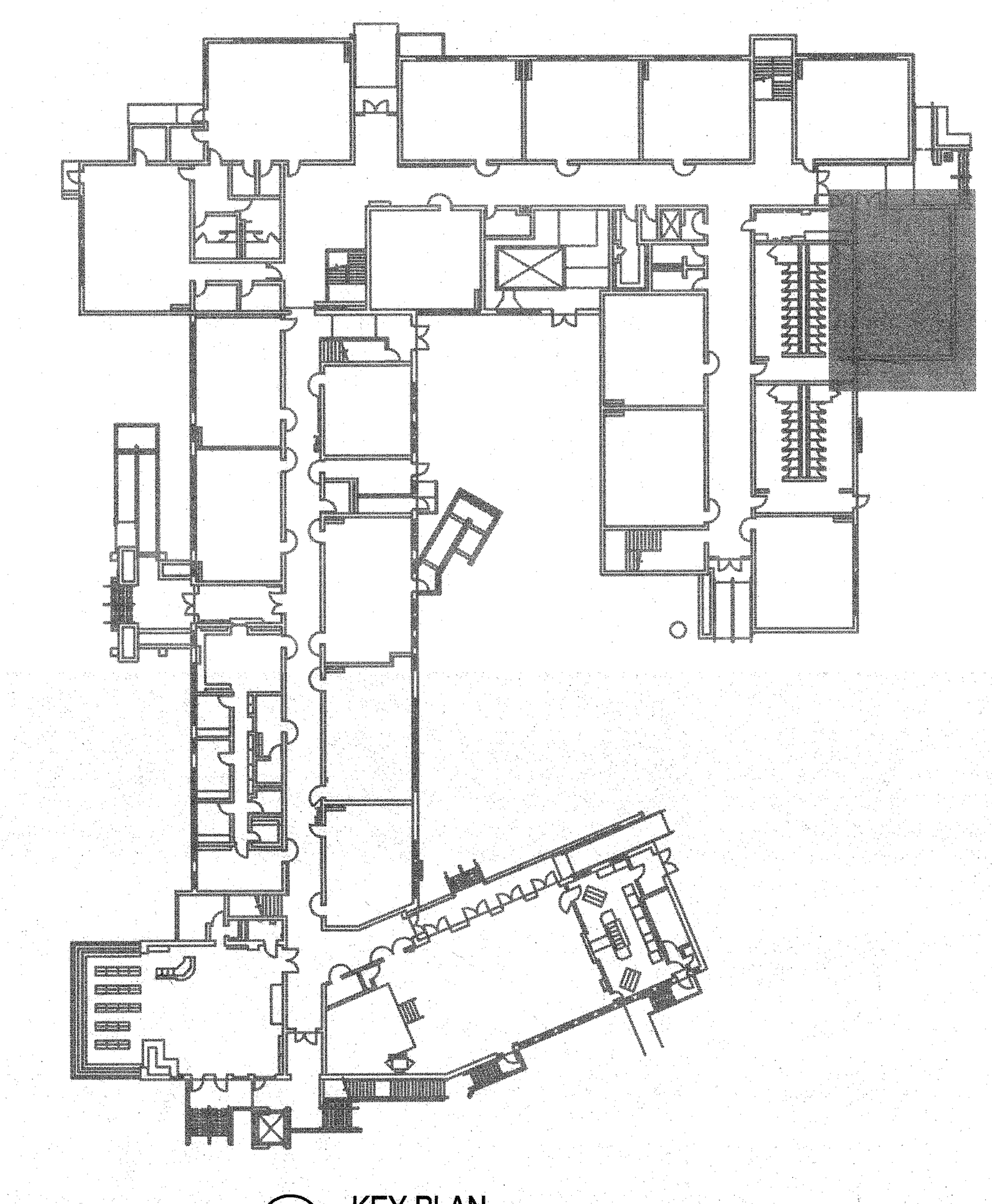


1 GROUND FLOOR PLAN
SCALE = 1/4"=1'-0"

EQUIPMENT SCHEDULE (SEE NOTES)		
SYMBOL	MAX OPERATING WEIGHT (LBS.)	DETAIL REFERENCE(S)
CH 1	6,300	1/S2.0
BT 1	5,100	2/S2.0
CPF 1	100	4/M3.01

NOTES:

1. CONTRACTOR SHALL NOT CUT/DAMAGE (E) REINFORCING OR (E) CONCRETE TO REMAIN.
2. ANCHORS SHALL BE PLACED A MINIMUM OF 1½ ANCHOR DIAMETERS FROM (E) ANCHOR HOLES.
3. (E) ANCHOR HOLES WITHIN 6" OF NEW ANCHORS SHALL BE FILLED WITH GROUT.
4. IF REMOVAL OF (E) WALL BRACE FRAMING IS REQUIRED, PROVIDE TEMPORARY ENGINEERED BRACING FOR (E) ENCLOSURE WALLS WHILE (E) WALL BRACE FRAMING IS REMOVED. CONTRACTOR SHALL OBTAIN SHORING DESIGN FOR A MINIMUM ASCE 37-14 DESIGN LOADS FROM A CALIFORNIA LICENSED STRUCTURAL ENGINEER.
5. SEE MECH, ELEC DWGS FOR CONDUIT REMOVAL AND REINSTALLATION.
6. PRIOR TO INSTALLING NEW MECHANICAL UNITS, CONTRACTOR SHALL CUT ALL EXISTING ANCHORS FLUSH TO TOP OF (E) CONCRETE PAD.
7. ⇐ INDICATES TEMPORARY WALL BRACING, SEE NOTE 4.
8. PROJECT INSPECTOR SHALL INSPECT REINSTALLATION OF (E) STEEL FRAMING AND BOLTED CONNECTIONS FOR INSTALLATION BACK TO (E) CONDITION. SEE STRUCTURAL OBSERVATION NOTE 6.B ON S0.2
9. CONTRACTOR SHALL SUBMIT TO SEOR FOR REVIEW: SHORING CALCULATIONS AND EXECUTION PLAN FOR REMOVAL AND REINSTALLATION OF (E) FRAMING.
10. REINSTALLATION OF (E) STEEL FRAMING SHALL BE PER ORIGINAL DSA APPROVED DRAWING SHEETS (DSA A#51029): S-3, S-8, & S-9.
11. X INDICATES LOCATION OF PIPE SUPPORT SEE 6 & 7 ON M3.01
12. ↕ INDICATES BRACE LOCATIONS SEE 6 & 7 ON M3.01



KEY PLAN
SCALE = 1/32"=1'-0"

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SECOND FLOOR AND ROOF FRAMING PLAN

S1.0

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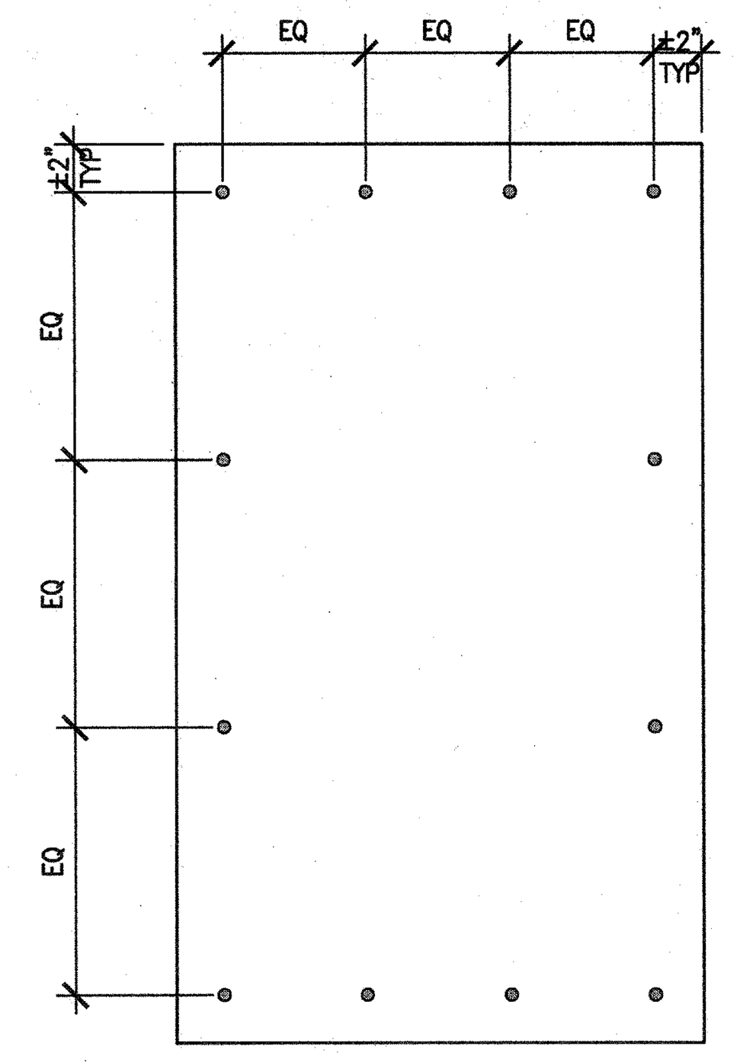
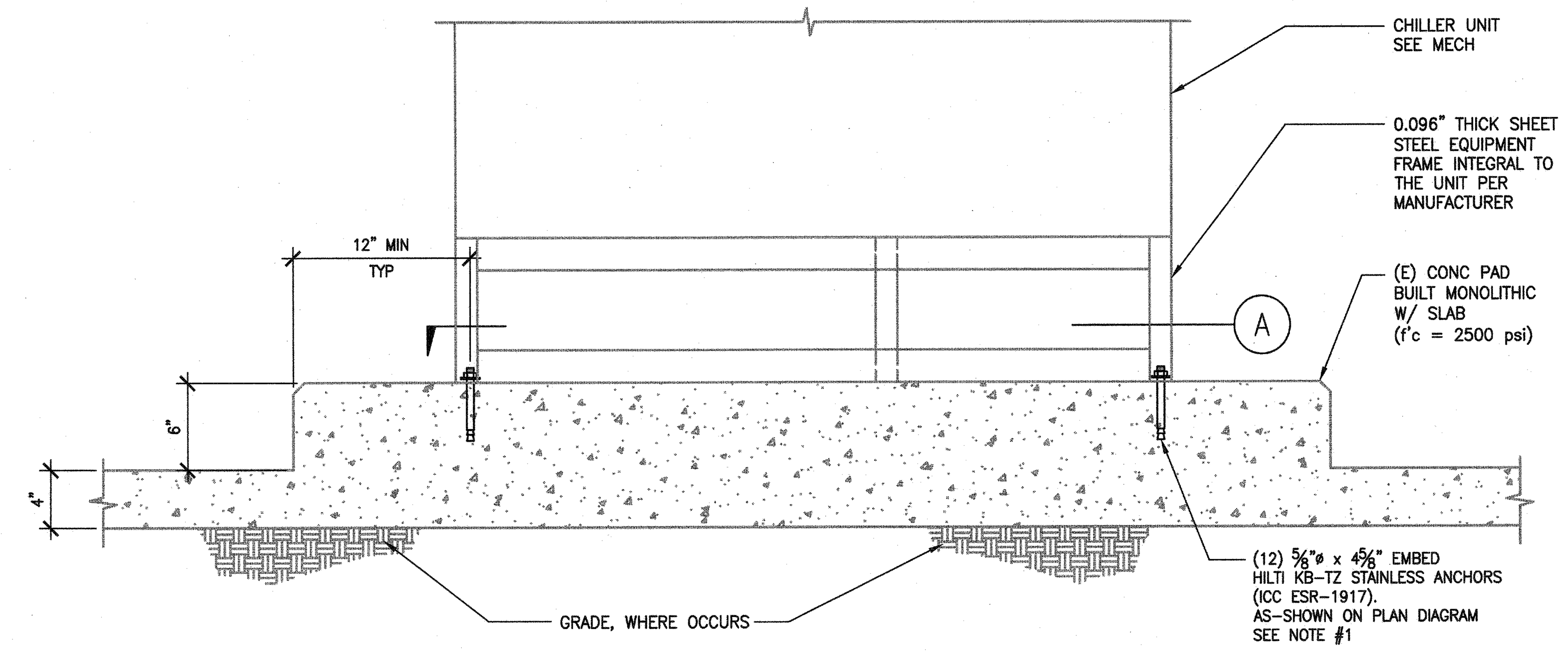
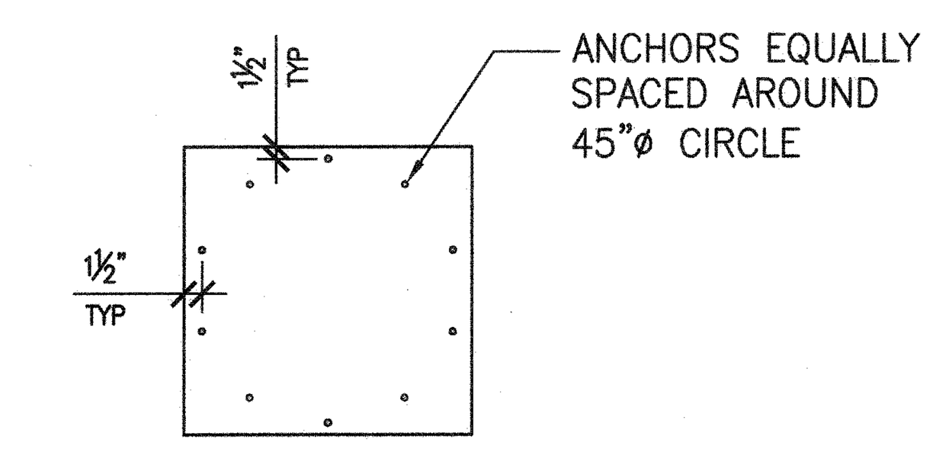


A ANCHOR LAYOUT DIAGRAM
NTS

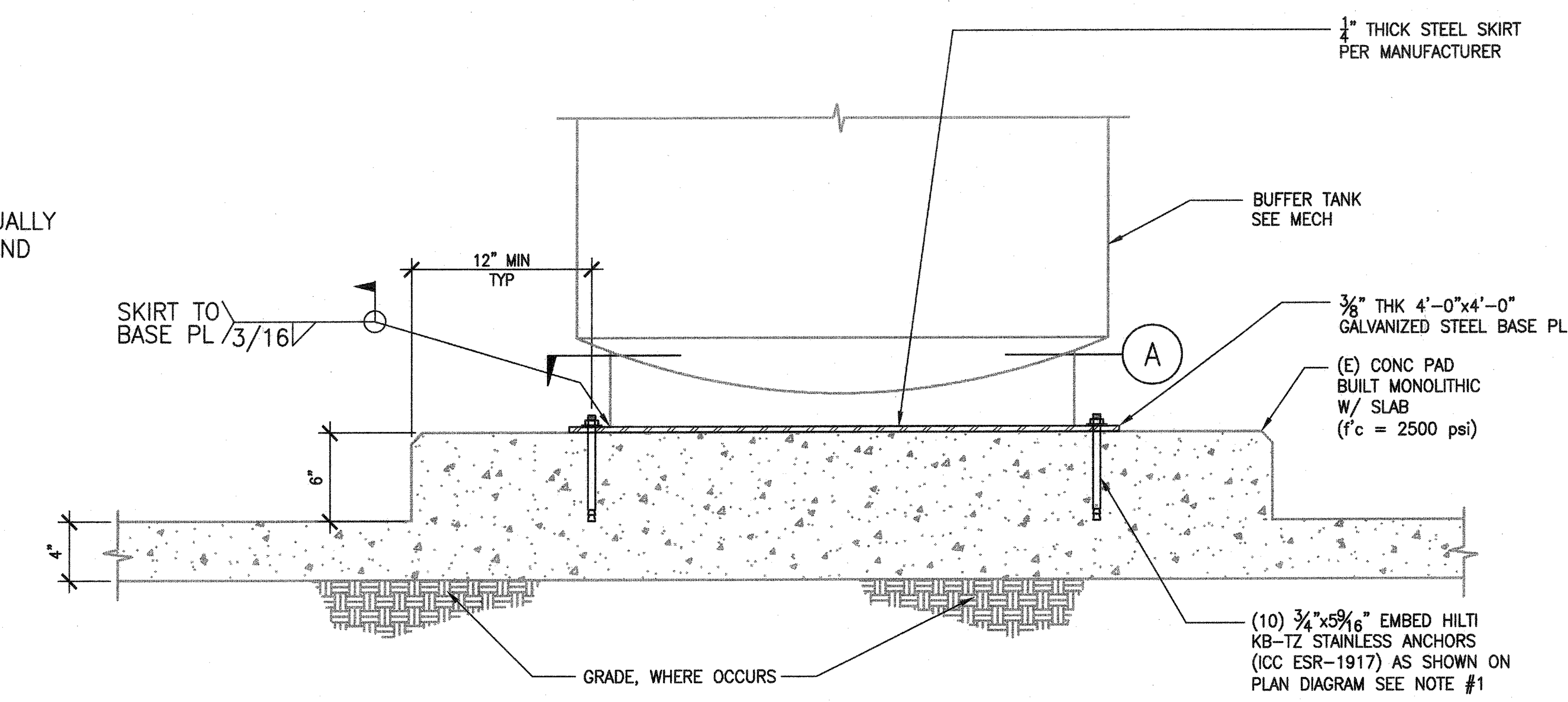


NOTES:
1. ANCHORS SHALL BE INSTALLED MINIMUM OF (3) ANCHOR DIAMETER AWAY FROM (E) ANCHORS.

CHILLER UNIT ANCHORAGE — 1 1/2"=1'-0" — 1



A ANCHOR LAY-OUT DIAGRAM
NTS



NOTES:
1. ANCHORS SHALL BE INSTALLED MINIMUM OF (3) ANCHOR DIAMETER AWAY FROM (E) ANCHORS.

BUFFER TANK UNIT ANCHORAGE — 1 1/2"=1'-0" — 2

CONSTRUCTION DOCUMENTS

IDENTIFICATION STAMP
DIVISION OF STATE ARCHITECT
OFFICE OF REGULATION SERVICES
FILE NO. 19-41
APPL. NO. 03-118364
AC ✓ FLS ✓ SS VC
DATE FEB 07 2018

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117 E. Colorado Blvd, Suite 200
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NAC ARCHITECTURE
nacarchitecture.com
837 NORTH SPRING STREET, THIRD FLOOR
LOS ANGELES CA 90012
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NAC NO	161-17036
DRAWN	TT
CHECKED	AO
DATE	10-05-2017

DETAILS

S2.0

LEGEND

SYMBOL	ABBR.	DESCRIPTION
⊠	–	SUPPLY AIR RISER
◪	–	RETURN AIR RISER
⊠	–	EXHAUST AIR RISER
⊠	SAG	SUPPLY AIR GRILLE
⊘	RAG	RETURN AIR GRILLE
⊠	EAG	EXHAUST AIR GRILLE
☐	SWR	SIDEWALL REGISTER
	(L)	LINED DUCTWORK
	–	FLEXIBLE CONNECTION
	FC	FLEXIBLE CONNECTION
	–	NEW DUCT (SEE PLAN)
	–	EXISTING DUCT (SEE PLAN)
	–	DEMO DUCT (SEE PLAN)
	MVD	MANUAL VOLUME DAMPER
	BDD	BACKDRAFT DAMPER
S/F — — —	SFD	SMOKE / FIRE DAMPER
F — — —	FD	FIRE DAMPER
▭	DL	DOOR LOUVER
U.C.	UC	UNDERCUT DOOR 3/4"
—RS—	RS	REFRIGERANT SUCTION LINE
—RL—	RL	REFRIGERANT LIQUID LINE
—CD—	CD	CONDENSATE DRAIN
⬢	S.D.	SMOKE DETECTOR
⊗	P.O.C.	POINT OF CONNECTION
Ⓣ	T-STAT	THERMOSTAT
Ⓗ	H	HUMIDISTAT
(TS)	TS	TEMPERATURE SENSOR
(OS)	OS	OVERRIDE SWITCH
(PD)	PD	PRESSURE DIFFERENTIAL SWITCH
Ⓢ	S	SWITCH
	O.C.	ON CENTER
	HWR	HOT-WATER RETURN
	HWS	HOT-WATER SUPPLY
	I.D.	INSIDE DIAMETER
	O.D.	OUTSIDE DIAMETER
	W/	WITH
	S/M	SHEET METAL
	S/S	STAINLESS STEEL
	G.C.	GENERAL CONTRACTOR
	VTR	VENT THRU ROOF
	EMS	ENERGY MANAGEMENT SYSTEM
	OBD	OPPOSED BLADE DAMPER
	FSC	FAN SPEED CONTROL
Ⓔ	E	ITEMS FURNISHED AND INSTALLED BY ELECTRICAL CONTRACTOR AS SPECIFIED ON THE ELECTRICAL CONTRACT DOCUMENTS
Ⓜ	M	ITEMS FURNISHED AND INSTALLED BY MECHANICAL CONTRACTOR AS SPECIFIED ON THE MECHANICAL CONTRACT DOCUMENTS
(EM)	EM	ITEMS FURNISHED BY ELECTRICAL CONTRACTOR AND INSTALLED BY MECHANICAL CONTRACTOR.
(ME)	ME	ITEMS FURNISHED BY MECHANICAL CONTRACTOR AND INSTALLED BY ELECTRICAL CONTRACTOR.
	C.C.	CONTROLS CONTRACTOR
	CBD	COUNTER-BALANCE DAMPER
(DS)	D.S.	DOOR SWITCH

MEP COMPONENT ANCHORAGE NOTE

ALL MECHANICAL, PLUMBING, AND ELECTRICAL COMPONENTS SHALL BE ANCHORED AND INSTALLED PER THE DETAILS ON THE DSA APPROVED CONSTRUCTION DOCUMENTS. WHERE NO DETAIL IS INDICATED, THE FOLLOWING COMPONENTS SHALL BE ANCHORED OR BRACED TO MEET THE FORCE AND DISPLACEMENT REQUIREMENTS PRESCRIBED IN THE 2016 CBC, SECTIONS 1616A.1.18 THROUGH 1616A.1.26 AND ASCE 7-10 CHAPTERS 13, 26 AND 30.

1. ALL PERMANENT EQUIPMENT AND COMPONENTS.
2. TEMPORARY OR MOVABLE EQUIPMENT THAT IS PERMANENTLY ATTACHED (E.G. HARD WIRED) TO THE BUILDING UTILITY SERVICES SUCH AS ELECTRICITY, GAS OR WATER.
3. MOVABLE EQUIPMENT WHICH IS STATIONED IN ONE PLACE FOR MORE THAN 8 HOURS AND HEAVIER THAN 400 POUNDS ARE REQUIRED TO BE ANCHORED WITH TEMPORARY ATTACHMENTS.

THE FOLLOWING MECHANICAL AND ELECTRICAL COMPONENTS SHALL BE POSITIVELY ATTACHED TO THE STRUCTURE, BUT NEED NOT BE DETAILED ON THE PLANS. THESE COMPONENTS SHALL HAVE FLEXIBLE CONNECTIONS PROVIDED BETWEEN THE COMPONENT AND ASSOCIATED DUCTWORK, PIPING, AND CONDUIT.

A. COMPONENTS WEIGHING LESS THAN 400 POUNDS AND HAVE A CENTER OF MASS LOCATED 4 FEET OR LESS ABOVE THE ADJACENT FLOOR OR ROOF LEVEL THAT DIRECTLY SUPPORT THE COMPONENT.
B. COMPONENTS WEIGHING LESS THAN 20 POUNDS, OR IN THE CASE OF DISTRIBUTED SYSTEMS, LESS THAN 5 POUNDS PER FOOT, WHICH ARE SUSPENDED FROM A ROOF OR FLOOR OR HUNG FROM A WALL.

FOR THOSE ELEMENTS THAT DO NOT REQUIRE DETAILS ON THE APPROVED DRAWINGS, THE INSTALLATION SHALL BE SUBJECT TO THE APPROVAL OF THE DESIGN PROFESSIONAL IN GENERAL RESPONSIBLE CHARGE OR STRUCTURAL ENGINEER DELEGATED RESPONSIBILITY AND THE DSA DISTRICT STRUCTURAL ENGINEER THROUGH A CCD OR ADDENDUM. THE PROJECT INSPECTOR WILL VERIFY THAT ALL COMPONENTS AND EQUIPMENT HAVE BEEN ANCHORED IN ACCORDANCE WITH ABOVE REQUIREMENTS.

PIPING, DUCTWORK, AND ELECTRICAL DISTRIBUTION SYSTEM ANCHORAGE NOTE

PIPING, DUCTWORK, AND ELECTRICAL DISTRIBUTION SYSTEMS SHALL BE BRACED TO COMPLY WITH THE FORCE AND DISPLACEMENTS PRESCRIBED IN ASCE 7-10 SECTION 13.3, AS DEFINED IN ASCE 7-10 SECTION 13.6.5.6, 13.6.7, 13.6.8, AND 2016 CBC SECTIONS 1616A.1.23, 1615A.1.24, 1616A.1.25, AND 1616A.1.26.

THE METHOD OF SHOWING BRACING AND ATTACHMENTS TO THE STRUCTURE FOR THE IDENTIFIED DISTRIBUTION SYSTEM ARE AS NOTED BELOW. WHEN BRACING AND ATTACHMENTS ARE BASED ON A PREAPPROVED INSTALLATION GUIDE (E.G. SMACNA OR OSHPD OPM), COPIES OF THE BRACING SYSTEM INSTALLATION GUIDE OR MANUAL SHALL BE AVAILABLE ON THE JOBSITE PRIOR TO THE START OF AND DURING THE HANGING AND BRACING OF THE DISTRIBUTION SYSTEMS. THE STRUCTURAL ENGINEER OF RECORD SHALL VERIFY THE ADEQUACY OF THE STRUCTURE TO SUPPORT THE HANGER AND BRACE LOADS.

MECHANICAL PIPING (MP), MECHANICAL DUCTS (MD), PLUMBING PIPING (PP), ELECTRICAL DISTRIBUTION SYSTEMS (E):

MP [X] MD [ ] PP [X] E [ ] – OPTION 1: DETAILED ON THE APPROVED DRAWINGS WITH PROJECT SPECIFIC NOTES AND DETAILS.
MP [ ] MD [ ] PP [ ] E [ ] – OPTION 2: SHALL COMPLY WITH THE APPLICABLE OSHPD PRE-APPROVAL (OPM #) # OPM 0043-13 .
MP [ ] MD [ ] PP [ ] E [ ] – OPTION 3: SHALL COMPLY WITH THE SMACNA SEISMIC RESTRAINT MANUAL, OSHPD EDITION (2009), INCLUDING ANY ADDENDA. FASTENERS AND OTHER ATTACHMENTS NOT SPECIFICALLY IDENTIFIED IN THE SMACNA SEISMIC RESTRAINT MANUAL, OSHPD EDITION, ARE DETAILED ON THE APPROVED DRAWINGS WITH PROJECT SPECIFIC NOTES AND DETAILS. THE DETAILS SHALL ACCOUNT FOR THE APPLICABLE SEISMIC HAZARD LEVEL _____ AND CONNECTION LEVEL _____ FOR THE PROJECT AND CONDITIONS.

CA GREEN BUILDING STANDARDS NOTES

ENTIRE INSTALLATION SHALL COMPLY WITH THE 2016 CALIFORNIA GREEN BUILDING STANDARDS (CALGREEN) CODE INCLUDING THE FOLLOWING APPLICABLE MANDATORY MEASURES:

1. 5.504.1.3 - PERMANENT HVAC SYSTEM SHALL ONLY BE USED DURING CONSTRUCTION IF NECESSARY TO CONDITION THE BUILDING WITHIN THE REQUIRED TEMPERATURE RANGE FOR MATERIAL AND EQUIPMENT INSTALLATION. IF THE HVAC SYSTEM IS USED DURING CONSTRUCTION, CONTRACTOR SHALL USE MERV 8 MINIMUM RETURN AIR FILTERS. REPLACE ALL FILTERS IMMEDIATELY PRIOR TO OCCUPANCY.
2. 5.504.3 - AT THE TIME OF ROUGH INSTALLATION AND DURING STORAGE ON THE CONSTRUCTION SITE UNTIL FINAL STARTUP OF THE HEATING, COOLING AND VENTILATING EQUIPMENT, ALL DUCT AND OTHER RELATED AIR DISTRIBUTION COMPONENT OPENINGS SHALL BE COVERED WITH TAPE, PLASTIC, SHEETMETAL OR OTHER METHODS ACCEPTABLE TO THE ENFORCING AGENCY TO REDUCE THE AMOUNT OF DUST, WATER AND DEBRIS WHICH MAY ENTER THE SYSTEM.
3. 5.504.5.3.1 - IN MECHANICALLY VENTILATED BUILDINGS, PROVIDE REGURLARLY OCCUPIED AREAS OF THE BUILDING WITH AIR FILTRATION MEDIA FOR OUTSIDE AND RETURN AIR PRIOR TO OCCUPANCY THAT PROVIDES AT LEAST A MINIMUM EFFICIENCY REPORTING VALUE (MERV) OF 8. MERV 8 FILTERS SHALL BE INSTALLED PRIOR TO OCCUPANCY AND RECOMMENDATIONS FOR MAINTENANCE WITH FILTERS OF THE SAME VALUE SHALL BE INCLUDED IN THE OPERATION AND MAINTENANCE MANUAL.

EXCEPTIONS:

1. AN ASHRAE 10-PERCENT TO 15-PERCENT EFFICIENCY FILTER SHALL BE PERMITTED FOR AN HVAC UNIT MEETING THE 2016 CALIFORNIA ENERGY CODE HAVING 60,000 BTU/H OR LESS CAPACITY PER FAN COIL, IF THE ENERGY USE OF THE AIR DELIVERY SYSTEM IS 0.4 W/CFM OR LESS AT THE DESIGN AIR FLOW.

2. EXISTING MECHANICAL EQUIPMENT.

4. 5.504.5.3.1 - INSTALLED FILTERS SHALL BE CLEARLY LABELED BY THE MANUFACTURER INDICATING THE MERV RATING.
5. 5.504.7 - OUTDOOR SMOKING AREAS SHALL BE MINIMUM 25'-0" FROM ALL BUILDING ENTRIES, OUTDOOR AIR INTAKES, AND OPERABLE WINDOWS.
6. 5.505.1 - BUILDINGS SHALL MEET OR EXCEED THE PROVISIONS OF CALIFORNIA BUILDING CODE, CCR, TITLE 24, PART 2, SECTIONS 1203 (VENTILATION) AND CHAPTER 14 (EXTERIOR WALLS). FOR ADDITIONAL MEASURES NOT APPLICABLE TO LOW-RISE RESIDENTIAL OCCUPANCIES, SEE SECTION 5.407.2 OF THIS CODE.
7. 5.506.1 - FOR MECHANICALLY OR NATURALLY VENTILATED SPACES IN BUILDINGS, MEET THE MINIMUM REQUIREMENTS OF SECTION 121 (REQUIREMENTS FOR VENTILATION) OF THE 2010 CALIFORNIA ENERGY CODE, OR THE APPLICABLE LOCAL CODE, WHICHEVER IS MORE STRINGENT, AND DIVISION 1, CHAPTER 4 OR CCR, TITLE 8.
8. 5.506.2 - DEMAND CONTROL VENTILATION REQUIRED FOR ALL DENSELY OCCUPIED SPACES PER 2016 CALIFORNIA ENERGY CODE REQUIREMENTS.
9. 5.508.1 - INSTALL HVAC AND REFRIGERATION AND FIRE SUPPRESSION EQUIPMENT SHALL COMPLY WITH 5.508.1.1 AND 5.508.1.2.
   A. 5.508.1.1 & 5.5081.2 - INSTALL HVAC, REFRIGERATION AND FIRE SUPPRESSION EQUIPMENT THAT DO NOT CONTAIN CFCs AND HALONS.

GENERAL NOTES

----- GENERAL NOTES ----

1. ENTIRE INSTALLATION SHALL CONFORM TO THE REQUIREMENTS OF THE 2016 CALIFORNIA MECHANICAL CODE, 2016 CALIFORNIA BUILDING CODE, AND ALL OTHER APPLICABLE CODES AND REGULATIONS, INCLUDING 2016 CALIFORNIA ENERGY CONSERVATION STANDARDS DIVISION T-24.
2. 2016 CALIFORNIA GREEN BUILDING STANDARDS (CALGREEN) CODE INCLUDING THE APPLICABLE MANDATORY MEASURES:

   - COVERING OF DUCT OPENINGS AND PROTECTION OF MECHANICAL EQUIPMENT DURING CONSTRUCTION PER CALGREEN REQUIREMENTS.

   - ADHESIVES, SEALANTS AND CAULKS SHALL MEET CALGREEN REQUIREMENTS.

   - FILTERS SHALL BE A MINIMUM EFFICIENCY REPORTING VALUE (MERV) OF 8 OR AS SPECIFIED.

   - INSTALLATIONS OF HVAC AND REFRIGERATION EQUIPMENT SHALL COMPLY WITH SECTIONS 5.508.1.1 AND 5.508.1.2.
3. COORDINATE ENTIRE INSTALLATION OF THE HVAC SYSTEM WITH THE WORK OF ALL OTHER TRADES PRIOR TO ANY FABRICATION OR INSTALLATION. PROVIDE ALL FITTINGS, OFFSETS, AND TRANSITIONS AS REQUIRED FOR A COMPLETE WORKABLE INSTALLATION. THE MECHANICAL CONTRACTOR SHALL BE RESPONSIBLE TO COORDINATE ITEMS TO BE PROVIDED BY OTHER TRADES WHERE MENTIONED IN THE CONTRACT DOCUMENTS PRIOR TO BID - NO EXCEPTIONS.
4. COORDINATE THE LOCATIONS OF ALL CEILING DIFFUSERS, REGISTERS, AND GRILLES WITH THE ARCHITECTURAL REFLECTIVE CEILING PLAN, ELECTRICAL LIGHTING LAYOUT AND ARCHITECTURAL ROOM ELEVATIONS. THE ARCHITECT AND ENGINEER SHALL BE IMMEDIATELY NOTIFIED OF ANY CONFLICTS PRIOR TO FABRICATION AND INSTALLATION.
5. ALL EQUIPMENT, DUCTS, PIPING, AND OTHER DEVICES AND MATERIALS INSTALLED OUTSIDE OF THE BUILDING OR OTHERWISE EXPOSED TO THE WEATHER SHALL BE COMPLETELY WEATHER-PROOFED AND PAINTED TO MATCH, COORDINATE WITH ARCHITECT PRIOR TO PAINTING.
6. THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH AND BE CONSIDERED TO BE PART OF A SEPARATE AND COMPLETE MECHANICAL SPECIFICATION.
7. ALL DIMENSIONS SHOWN ON THESE PLANS ARE APPROXIMATE AND MUST BE CONFIRMED ON SITE.
8. PRIOR TO OCCUPANCY, THE ENTIRE H.V.A.C. SYSTEMS SHALL BE BALANCED IN ACCORDANCE WITH (AABC) ASSOCIATED AIR BALANCE COUNCIL STANDARDS BY AN INDEPENDENT AIR BALANCE CONTRACTOR. CERTIFICATION SHALL BE PROVIDED BY THE CONTRACTOR FOR AIR AND HYDRONIC AS APPLICABLE. SYSTEMS SHALL BE BALANCED AS INDICATED ON PLANS INCLUDING FRESH AIR VENTILATION. WHERE THERE IS A CONFLICT WITH THE MECHANICAL PLANS, THE AIR BALANCE CONTRACTOR SHALL NOTIFY THE ENGINEER PRIOR TO BALANCING OF SYSTEM. IF NOT THE AIR BALANCE CONTRACTOR SHALL BEAR ALL COSTS INCURRED FOR WORK THAT MUST BE RE-BALANCED DUE TO CONFLICTS ON CONTRACT DOCUMENTS. CONTRACTOR SHALL PROVIDE THREE COPIES OF THE AIR BALANCE REPORT TO THE ENGINEER FOR APPROVAL.
9. FOR INACCESSIBLE AREAS THE CONTRACTOR SHALL PROVIDE ACCESS PANELS FOR ALL DAMPERS, EQUIPMENT, SMOKE DETECTORS, AND CONTROL DEVICES. THESE PANELS SHALL MATCH THE RATING OF THE WALL AND/OR CEILING THAT THEY ARE LOCATED IN. MINIMUM ACCESS PANEL SIZES SHALL BE AS FOLLOWS:

   1) HAND ACCESS: 12"x12"

   2) BODY ACCESS: 30"x30" MIN. WHERE A LARGER ACCESS SIZE IS REQUIRED DUE TO INSTALLATION CONSTRAINTS, THE CONTRACTOR SHALL DO SO AT NO ADDITIONAL COST AND SHALL NOTIFY THE ARCHITECT AND ENGINEER OF DEVIATIONS PRIOR TO INSTALLATION.
10. NOT USED.
11. PLATFORMS, CURBS, AND FLASHINGS FOR MECHANICAL EQUIPMENT SHALL BE AS INDICATED ON THE STRUCTURAL AND ARCHITECTURAL PLANS, UNLESS NOTED OTHERWISE. WHERE THERE IS A CONFLICT WITH THE MECHANICAL PLANS, THE CONTRACTOR SHALL NOTIFY THE ARCHITECT AND ENGINEER PRIOR TO FABRICATION AND INSTALLATION.
12. ALL EQUIPMENT, ACCESSORIES, AND RELATED PIPING SHALL BE INSTALLED IN STRICT ACCORDANCE WITH THE EQUIPMENT MANUFACTURER'S RECOMMENDATIONS. PROVIDE ALL FITTINGS, TRANSITIONS, DAMPERS, VALVES, AND OTHER DEVICES REQUIRED FOR A COMPLETE WORKABLE INSTALLATION.
13. MAINTENANCE LABEL SHALL BE AFFIXED TO ALL MECHANICAL EQUIPMENT AND A MAINTENANCE MANUAL SHALL BE PROVIDED FOR THE OWNER'S USE.
14. NOT USED.
15. NOT USED.
16. ALL EQUIPMENT WITH MOVING PARTS SHALL BE PROVIDED WITH FLEXIBLE DUCT AND PIPE CONNECTIONS.
17. CONCEALED SPACES, CIRCULATING AIR: NO COMBUSTIBLE MATERIAL USED FOR EXPOSED COMMUNICATION CABLES, INSULATED WIRES, PLASTIC TUBING OR PIPING, PIPE INSULATION, CONDENSATE PAN INSULATION, WOOD, PVC, ABS, AND OTHER PLASTICS SHALL BE INSTALLED IN CONCEALED SPACES USED TO CONVEY CIRCULATING AIR SUPPLY.
18. ALL EQUIPMENT SHALL BE LABELED AS TO THE SPACE IT SERVES. SEE PLANS AND SPECIFICATIONS FOR IDENTIFICATION STANDARDS.
19. ALL HVAC EQUIPMENT SHALL BE CERTIFIED BY THE CALIFORNIA ENERGY COMMISSION TO COMPLY WITH LATEST EFFICIENCY STANDARDS.
20. AC UNITS PROVIDED WITH ECONOMY CYCLE DAMPERS SHALL HAVE DAMPERS SET UP TO CLOSE AUTOMATICALLY ON FAN SHUTDOWN.
21. ALL FRESH AIR INTAKES SHALL MEET CODE REQUIRED CLEARANCES FROM EXHAUST, FLUE, FUEL BURNING APPLIANCE AND PLUMBING VENT OUTLETS. FOR GAS/ELECTRIC AIR CONDITIONING UNITS WHERE THE CODE REQUIRED CLEARANCES ARE NOT MET, A FACTORY FLUE GAS DEFLECTOR AND EXTENSION SHALL BE USED TO MINIMIZE THESE CLEARANCES. CONTRACTOR SHALL DETERMINE LOCATIONS WHERE REQUIRED PRIOR TO BID. THIS SHALL BE PROVIDED AT NO ADDITIONAL COST.
22. ALL AIR HANDLING EQUIPMENT SERVING CONDITIONED SPACES SHALL PROVIDE CONTINUOUS FRESH AIR TO SPACES IN OCCUPIED MODE.
23. CONTRACTOR SHALL VERIFY ALL CLEARANCES AND AVAILABLE SPACE FOR DUCTWORK PRIOR TO ORDERING AND/OR FABRICATING MATERIAL.
24. CONTRACTOR TO SUBMIT ALL EQUIPMENT AND ACCESSORIES TO THE ENGINEER FOR APPROVAL PRIOR TO ANY ORDERING OF SUCH ITEMS.
25. CONTRACTOR SHALL BE RESPONSIBLE FOR COMMISSIONING OF EQUIPMENT AS STIPULATED ON MECH-1-C FORM ON PLANS UNLESS NOTED OTHERWISE.
26. PAINT EXPOSED SURFACES, WHETHER OR NOT COLORS ARE DESIGNATED IN SCHEDULES, EXCEPT WHERE A SURFACE OR MATERIAL IS SPECIFICALLY INDICATED NOT TO BE PAINTED OR IS TO REMAIN NATURAL. WHERE AN ITEM OR SURFACE IS NOT SPECIFICALLY MENTIONED, PAINT THE SAME AS SIMILAR ADJACENT MATERIALS OR SURFACES. IF COLOR OR FINISH IS NOT DESIGNATED, THE OWNER'S REPRESENTATIVE WILL SELECT FROM STANDARD COLORS OR FINISHES AVAILABLE.

   1) PAINTING INCLUDES FIELD PAINTING EXPOSED BARE AND COVERED PIPES AND DUCTS (INCLUDING COLOR CODING), HANGERS, EXPOSED STEEL AND IRON WORK, AND PRIMED METAL SURFACES OF MECHANICAL AND ELECTRICAL EQUIPMENT.

----- CONTROLS -----

27. CONTROL SCHEMATICS ARE FOR SEQUENCE ONLY. REFER TO ELECTRICAL DRAWINGS AND SPECIFICATIONS FOR ALL ELECTRICAL DEVICES REQUIRED.
28. ALL LINE VOLTAGE WIRING SHALL BE INSTALLED IN CONDUIT. ALL LINE VOLTAGE CONDUIT AND WIRING, INCLUDING FINAL CONNECTIONS, SHALL BE FURNISHED AND INSTALLED BY THE ELECTRICAL CONTRACTOR AS INDICATED ON THE ELECTRICAL DRAWINGS OR SPECIFIED IN THE ELECTRICAL SECTION OF THE SPECIFICATIONS. ALL ELECTRICAL WORK SHALL BE INSTALLED IN ACCORDANCE WITH ALL APPLICABLE CODES AND REGULATIONS OF ALL GOVERNING BODIES HAVING JURISDICTION THEREOF.
29. ALL LOW VOLTAGE CONDUIT AND WIRING AS APPLICABLE, INCLUDING FINAL CONNECTIONS, SHALL BE FURNISHED AND INSTALLED BY THE MECHANICAL CONTRACTOR AS INDICATED ON THE MECHANICAL DRAWINGS OR SPECIFIED IN THE MECHANICAL SECTION OF THE SPECIFICATIONS.

   A1) ALL LOW VOLTAGE WIRING SHALL BE INSTALLED IN CONDUIT.

   A2) ALL LOW VOLTAGE WIRING SHALL BE PLENUM - RATED.

   B) WHERE THE CONTROLS CONTRACTOR IS RETAINED BY THE OWNER, THEY SHALL BE RESPONSIBLE FOR THE FOLLOWING:

   1) FURNISH AND INSTALL ALL DEVICES, WIRING, AND TERMINATIONS REQUIRED FOR A COMPLETE AND FUNCTIONAL INSTALLATION.

   2) COORDINATE ALL WORK AND REQUIREMENTS WITH OTHER TRADES INCLUDING GENERAL, MECHANICAL, AND ELECTRICAL CONTRACTORS PRIOR TO BID.

   3) CONTRACTOR SHALL FOLLOW ALL SUBMITTAL REQUIREMENTS PER DRAWINGS AND SPECIFICATIONS.
30. CONTRACTOR SHALL BE RESPONSIBLE FOR ORDERING AIR CONDITIONING EQUIPMENT WITH THRU-THE-BASE POWER, CONTROL, AND GAS CONNECTIONS. VERIFY ALL CONNECTION LOCATIONS WITH UNIT MANUFACTURER AND COORDINATE WITH OTHER TRADES AS NECESSARY.
31. ALL THERMOSTATS SHALL HAVE LOCKABLE COVERS (WHERE INDICATED ON PLANS) AND SHALL BE OF THE ELECTRONIC, PROGRAMMABLE, AUTOMATIC CHANGEOVER TYPE TO SEQUENCE HEATING OR COOLING. SET POINT RANGE SHALL BE 10 DEGREES F. BETWEEN FULL HEATING AND COOLING. THEY SHALL HAVE CAPABILITY OF TERMINATING ALL HEATING AT A TEMPERATURE NO MORE THAN 70 DEGREES F., AND COOLING AT A TEMPERATURE NOT LESS THAN 78 DEGREES F. ADJUSTABLE TEMPERATURE DIFFERENTIAL SHALL BE 1- 1/2 DEGREES F. CONTROL LIMITS SHALL BE FROM 55 DEGREES F. TO 85 DEGREES F. MOUNT AT 48 INCHES ABOVE FLOOR OR AS REQUIRED BY LOCAL AUTHORITIES OR HANDICAP CODES.

   NOTES: 1) THERMOSTATS THAT ARE PART OF AN ENERGY MANAGEMENT SYSTEM SHALL FOLLOW CONTROL SPECIFICATIONS AND DRAWING REQUIREMENTS.

   2) SHOULD THE LOCATION OF THE THERMOSTAT NOT MEET THE ADA HEIGHT REQUIREMENTS DUE TO OBSTRUCTIONS, THEN AN ALTERNATE LOCATION SHALL BE PROPOSED OR REQUESTED BY THE CONTRACTOR THAT SHALL BE APPROVED BY THE ENGINEER AND ARCHITECT.
32. LINE VOLTAGE THERMOSTATS SHALL BE FURNISHED BY THE MECHANICAL CONTRACTOR AND INSTALLED BY THE ELECTRICAL CONTRACTOR.
33. CONTROLS CONTRACTOR AND AIR BALANCE CONTRACTOR SHALL COORDINATE WORK AND PERFORM NECESSARY TASKS AS REQUIRED TO OBTAIN AIR AND WATER FLOW QUANTITIES FOR SYSTEMS SHOWN HEREIN.
34. CONTROLS SHALL BE PROVIDED TO PROVIDE THE MINIMUM RATE OF OUTDOOR AIR REQUIRED BY THE STATE ENERGY REGULATIONS.

----- AIR DISTRIBUTION ----

35. ALL DUCTWORK SHALL BE SHEET METAL CONSTRUCTED OR SPIRAL, ERECTED, AND TESTED IN ACCORDANCE WITH THE MOST RESTRICTIVE OF LOCAL REGULATIONS, PROCEDURES DETAILED IN THE ASHRAE HANDBOOK OF FUNDAMENTALS, CHAPTER 6 OF THE MECHANICAL CODE, OR THE APPLICABLE STANDARDS ADOPTED BY THE SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION.
36. ALL FLEXIBLE DUCTWORK SHALL NOT EXCEED SEVEN FEET IN LENGTH TO RESPECTIVE DIFFUSERS, GRILLES, AND REGISTERS, OR OTHER AIR DEVICES.
37. PROVIDE SEISMIC RESTRAINTS TO ALL DUCTWORK, PIPE, AND EQUIPMENT SUPPORTS IN ACCORDANCE WITH THE LATEST SMACNA GUIDELINES FOR SEISMIC RESTRAINT OF MECHANICAL SYSTEMS. SUSPENDED EQUIPMENT SHALL BE PROVIDED WITH SEISMIC ANCHORAGE AND ISOLATION SUPPORTS.
38. ALL DUCT TURNS IN SUPPLY, RETURN, AND EXHAUST DUCTS SHALL HAVE TURNING VANES UNLESS OTHERWISE NOTED.
39. DUCTWORK HANDLING CONDITIONED AIR SHALL BE INSULATED OR LINED AS INDICATED ON DRAWINGS. SUPPLY AND RETURN DUCT INSULATION SHALL BE MIN. 1.5" THICK, 3/4 LB./CUBIC FT. DENSITY AND HAVE A MIN. VALUE OF R-8 WHERE LOCATED IN ONE OR MORE OF THE FOLLOWING SPACES:

   A) OUTDOORS, OR

   B) IN A SPACE BETWEEN THE ROOF AND AN INSULATED CEILING, OR

   C) IN A SPACE DIRECTLY UNDER A ROOF WITH FIXED VENTS OR OPENINGS TO THE OUTSIDE OR UNCONDITIONED SPACES, OR

   D) IN AN UNCONDITIONED CRAWLSPACE; OR

   E) IN OTHER UNCONDITIONED SPACES

   PER 2016 CEC, OTHERWISE PROVIDE R-4.2 WHEN LOCATED IN CONDITIONED ATTIC SPACES ABOVE CEILINGS . ALL DUCTWORK EXPOSED ON ROOF SHALL BE INTERNALLY LINED WITH 1.5" THICK, 1.5LB./CUBIC FT. DENSITY DUCT LINER UNLESS OTHERWISE INDICATED OR SPECIFIED. ALL DUCT SIZES ARE SHEET METAL SIZES. ALL DUCT JOINTS SHALL BE SEALED PER CHAPTER 6 MECHANICAL CODE REQUIREMENTS. PROVIDE PIPING AND DUCT INSULATION IN ACCORDANCE WITH THE LATEST STANDARDS OF THE CALIFORNIA ENERGY COMMISSION.
40. ALL INSULATION SHALL HAVE A FLAME SPREAD OF NOT MORE THAN 25 AND A SMOKE DENSITY NOT EXCEEDING 50.
41. MANUAL VOLUME DAMPERS SHALL BE PROVIDED IN ALL DUCT BRANCHES TO INDIVIDUAL DIFFUSERS, GRILLES, AND REGISTERS, AS WELL AS FRESH AIR INTAKE DUCTS. DAMPERS SHALL BE LOCATED AT THE BRANCH DUCT LOCATIONS. THE MECHANICAL CONTRACTOR SHALL COORDINATE LOCATIONS OF DAMPERS WITH THE AIR BALANCE CONTRACTOR PRIOR TO BID, SO THEY ARE ACCESSIBLE PRIOR TO INSTALLATION. IN LOCATIONS WHERE THESE DAMPERS ARE INACCESSIBLE, CABLE OPERATED ADJUSTMENT CONTROLS SHALL BE PROVIDED AT NO ADDITIONAL COST. OPPOSED BLADE DAMPERS SHALL NOT BE PERMITTED UNLESS NOTED OTHERWISE.
42. AUTOMATIC FIRE DAMPER REQUIREMENTS ARE AS FOLLOWS:

   A) PROVIDE AUTOMATIC FIRE DAMPERS AT ALL PENETRATIONS OF FIRE-RATED CEILINGS AND WALLS THROUGHOUT. CONTRACTOR SHALL COORDINATE FIRE-RATED AREAS WITH THE ARCHITECTURAL DRAWINGS AND OTHER TRADES PRIOR TO INSTALL AND SHALL NOTIFY PERTINENT PARTIES PRIOR TO ANY WORK PERFORMED IN THESE AREAS. IN ADDITION, CONTRACTOR SHALL BE RESPONSIBLE TO PROVIDE PROPER ACCESS FOR DAMPERS INSTALLED. THE DAMPER FIRE RATING SHALL BE COMPATIBLE WITH THE CEILING/WALL RATING.

   B) LOCATION OF FIRE-RATED CEILINGS AND WALLS ARE AS INDICATED ON THE ARCHITECTURAL DRAWINGS.

   C) FIRE AND/OR SMOKE DAMPER(S) SHALL BE PROVIDED AS REQUIRED BY THE LATEST UNIFORM/CALIFORNIA BUILDING CODE.

   D) CONTRACTOR SHALL FURNISH FLUSH MOUNTED FIRE AND/OR SMOKE DAMPERS, SO THAT DAMPER DO NOT EXTEND PASS WALLS, FOR AREAS WITHOUT CEILINGS FOR QUALITY WORKMANSHIP.
43. ALL DUCTWORK PASSING THROUGH FIRE RATED CORRIDORS AND LOBBIES SHALL BE MIN. 26 GAGE SHEET METAL CONSTRUCTION.
44. ALL DUCTWORK, PIPING, CONDUIT, & ETC. PENETRATING FIRE RATED CONSTRUCTION SHALL HAVE APPROVED FIRE STOPPING.
45. UNLESS OTHERWISE NOTED THE CONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING AND INSTALLING EXTERIOR LOUVERS CALLED OUT HEREIN. SEE SPECIFICATIONS FOR LOUVER REQUIREMENTS. COORDINATE SIZE(S) AND LOCATION(S) WITH OTHER TRADES AS NECESSARY PRIOR TO BID.

AIR COOLED PACKAGED CHILLER SCHEDULE

SYM	MFR. & MODEL #	TOTAL CAPACITY (TONS)	MIN CAPACITY	AMBIENT TEMP	COMPRESSOR		WATER					PART LOAD RATING(EER)				EER	IPLV	ELECTRICAL					UNIT DIMS (IN)	MAX. OPER. WT. (LBS)	REMARKS	WIRING DETAIL	ANCHORAGE DETAIL
					QTY.	TYPE	GPM	MIN GPM	ENT. TEMP	LVG. TEMP	PD (FT)	100%	75%	50%	25%			V	PH	HZ	MCA	MOCP					
CH 1	DAIKIN AGZ090E	81.6	25%	100	4	SCROLL	177.3	80.1	55	44	6.6	9.6	13.5	18.4	20.5	10.5	17.0	460	3	60	179	200	150x88x99 (LxWxH)	6300	1, 2, 3, 4, 5, 6	5 M3.01	1 M3.01

1. INSTALL UNITS PER MANUFACTURER GUIDELINES.
2. INTEGRAL VARIABLE SPEED DUPLEX PUMP PACKAGE.
3. ACROSS THE LINE STARTER.
4. SINGLE POINT POWER CONNECTION.
5. BACNET MS/TP INTERFACE.
6. SOUND BLANKET.
5. AIR SEPARATOR W/STRAINER.
6. EXPANSION TANK (35 GAL).

CHEMICAL POT FEEDER SCHEDULE

SYM.	MFR. & MODEL	LOCATION	GALLONS	HEIGHT	DIAMETER	MAX. OPER. WT. (LBS)	REMARKS	ANCHORAGE DETAIL
CPF 1	GRISWOLD DB-5-SB-CS-Z	MECH YARD	5	34"	10"Ø	100	1, 2	4 M3.01

1. FUNNEL PACKAGE
2. VALVE PACKAGE

CHILLED WATER BUFFER TANK SCHEDULE

SYM.	MFR. & MODEL	SERVICE	TANK VOL. (GAL)	CONN. SIZE		MAXIMUM PRESSURE	TANK DIMS.(IN)		MAX. OPER. WT. (LBS)	REMARKS	ANCHORAGE DETAIL
				IN	OUT		DIA.	LENGTH			
BT 1	LOCHINVAR CVL-500	CHW	500	4	4	125 PSI	42"	87"	5100	1, 2, 3, 4	3 M3.01

1. TEMPERATURE AND PRESSURE GAUGE
2. FLANGED CONNECTIONS
3. AUTOMATIC AIR VENT
4. PROVIDE DRAIN CONNECTION

SHEET INDEX

M0.01	MECHANICAL GENERAL NOTES, LEGEND, AND SCHEDULES
M2.01	MECHANICAL DEMOLITION AND RENOVATION FLOOR PLANS
M3.01	MECHANICAL DETAILS
M3.02	MECHANICAL DETAILS
M4.01	TITLE 24 FORMS

CONSTRUCTION DOCUMENTS

IDENTIFICATION STAMP
DIVISION OF STATE ARCHITECT
OFFICE OF REGULATION SERVICES
FILE NO. 19-41
APPL. NO. 03-118364
AC ✓ FLS FB SS VC
DATE FEB 07 2018

PocockDesignSolutions Inc.

GLENDALE UNIFIED SCHOOL DISTRICT
MUIR ELEMENTARY SCHOOL - CHILLER UPGRADE
912 S. CHEVY CHASE DR,
GLENDALE, CA 91205

ANDREW R. GOSSMAN
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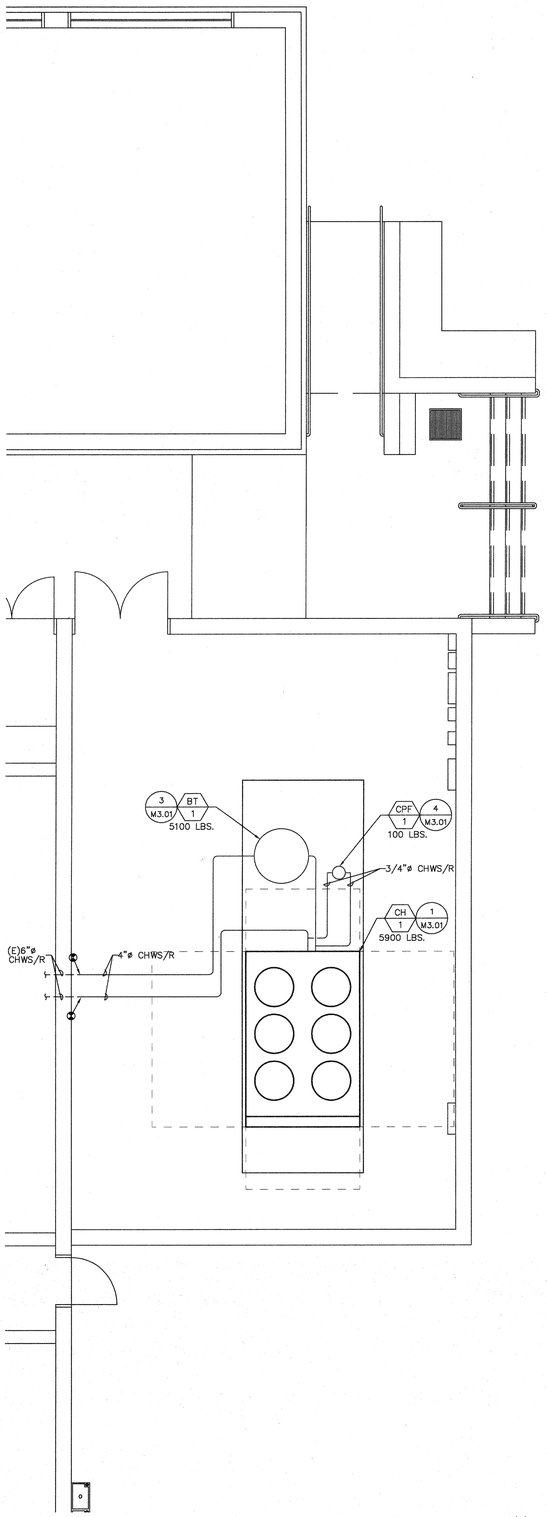
NAC NO 161-17036
DRAWN PM
CHECKED AG
DATE 01-16-2018

MECHANICAL
GENERAL NOTES,
LEGEND, AND
SCHEDULES

M0.01

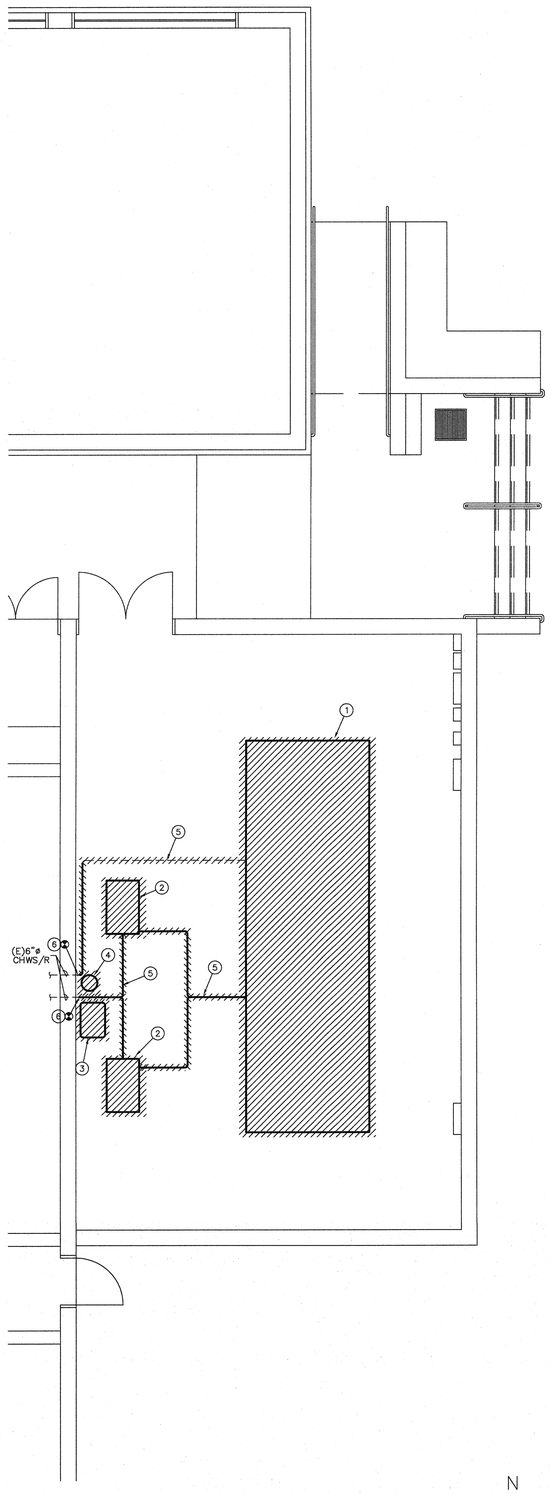
12/30/2015 9:39:00 AM File Path



2 MECHANICAL RENOVATION FLOOR PLAN

SCALE:
1/4" = 1'-0"

N



1 MECHANICAL DEMOLITION FLOOR PLAN

SCALE:
1/4" = 1'-0"

N

GENERAL NOTES:

1. DISTRICT SHALL HAVE FIRST RIGHT OF REFUSAL ON ALL ITEMS TO BE REMOVED. CONTRACTOR SHALL VERIFY ALL SUCH ITEMS WITH DISTRICT PRIOR TO REMOVAL. ALL ITEMS NOT REFUSED BY DISTRICT SHALL BE REMOVED INTACT AND FULLY FUNCTIONAL BY CONTRACTOR AND RETURNED TO DISTRICT. ALL ITEMS REFUSED BY DISTRICT SHALL BE PROPERLY DISPOSED OF BY CONTRACTOR.
2. ELECTRICAL CONTRACTOR SHALL DISCONNECT POWER FROM MECHANICAL EQUIPMENT TO BE REMOVED, RELOCATED, RE-USED AND/OR REPLACED AS REQUIRED.
3. PLUMBING CONTRACTOR SHALL DISCONNECT EXISTING DRAIN PIPES FROM MECHANICAL EQUIPMENT TO BE REMOVED AND/OR REPLACED – AS REQUIRED.
4. CONTRACTOR SHALL RE-USE EXISTING OPENINGS IN WALLS AND ROOF WHEREVER POSSIBLE. COORDINATE WITH OTHER TRADES AS NECESSARY.
5. GENERAL CONTRACTOR SHALL PATCH ALL OPENINGS IN WALLS, ROOF, ETC. THAT WILL NOT BE REUSED FOR FUTURE WORK. COORDINATE AS NECESSARY WITH OTHER TRADES.
6. PRIOR TO ANY WORK BEING DONE CONTRACTOR SHALL MAKE A CAREFUL EVALUATION OF THE EXISTING CONDITIONS AND VERIFY ALL METHODS OF REMOVAL AND INSTALLATION OF MECHANICAL EQUIPMENT.
7. CONTRACTOR SHALL COORDINATE ALL DEMOLITION WORK WITH THE WORK OF ALL OTHER TRADES.
8. ALL NEW PIPING SHALL BE ROUTED AND SUSPENDED UNDER EXISTING STRUCTURAL FRAMING IN MECHANICAL YARD. SEE DETAIL 6, M3.01.

KEYNOTES:

(1) DEMO AND REMOVE EXISTING CHILLER AND SUPPORTS.

(2) DEMO AND REMOVE EXISTING CHILLED WATER PUMPS.

(3) DEMO AND REMOVE EXISTING EXPANSION TANK.

(4) DEMO AND REMOVE EXISTING CHEMICAL POT FEEDER.

(5) DEMO AND REMOVE EXISTING CHILLED WATER PIPING TO POINT INDICATED.

(6) DEMO EXISTING PIPING TO POINT INDICATED (MINIMUM 6" FROM EXISTING WALL PENETRATION).

CONSTRUCTION DOCUMENTS

GLENDALE UNIFIED SCHOOL DISTRICT

MUIR ELEMENTARY SCHOOL - CHILLER UPGRADE

613 E. CHEVY CHASE DR.
GLENDALE, CA 91205

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APPL NO. 03-118366
AC FLS SS VC
DATE FEB 07 2018

PDS
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REGISTERED PROFESSIONAL ENGINEER
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CHECKED	AG
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MECHANICAL DEMOLITION AND RENOVATION FLOOR PLANS

M2.01

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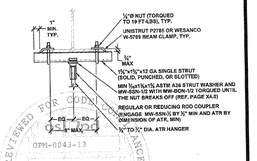
ATR HANGER ATTACHMENT TO STEEL BEAM WITH STEEL BEAM CLAMPS



HANGER CONNECTION TYPE	ALLOWABLE VERTICAL LOAD LBS	ATR HANGER DIA. INCH
38A TO 38N	2000	⅝
58A TO 58N	2500	⅝
63A TO 63N	2950	⅝
75A TO 75N	2000	⅝

SEE DETAIL M0.49 FOR SECTION NOTES
1 ATTACHMENT TO STEEL BEAM SHALL NOT BE PLACED WITHIN THE PROTECTED ZONE AS DEFINED IN AISC 341.

MASON WEST, INC.
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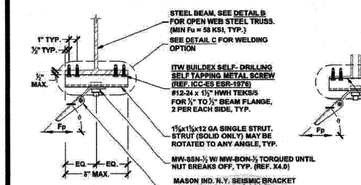
Jieh "Jeff" Zhang, SE
California SE No. S5270

PAGE M3.14

12/19/2016 OPM-0043-13; Reviewed for Code Compliance by Jeffrey Kikumoto Page 492 of 673

SEISMIC BRACKET ATTACHMENT TO STEEL BEAM OR OPEN WEB STEEL TRUSS WITH SELF-DRILLING FASTENERS OR WELDING



BRACE BRACKET ATTACHMENT TYPE	ALLOWABLE LATERAL LOAD Fp LBS	MAX BRACE RANGE δ
59A TO 59G	990	30°- 45°
59A TO 59P	480	46°- 60°

1 SEE DETAIL M0.49 FOR SECTION NOTES
2 ATTACHMENT TO STEEL BEAM SHALL NOT BE PLACED WITHIN THE PROTECTED ZONE AS DEFINED IN AISC 341.

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PAGE N3.11

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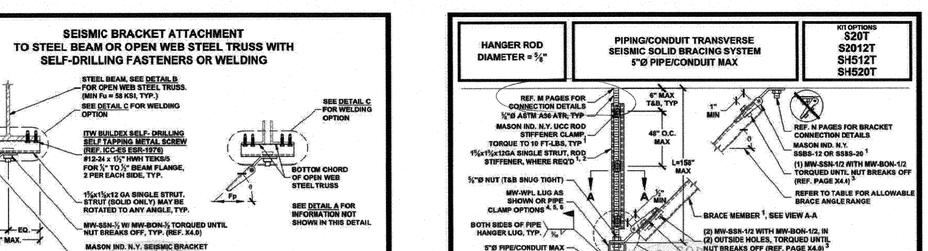
HANGER ROD DIAMETER = ⅝" — PIPING/CONDUIT TRANSVERSE SEISMIC SOLID BRACING SYSTEM 5"Ø PIPE/CONDUIT MAX

KIT OPTIONS: S20T, S2012T, SH512T, SH520T



BRACE ANGLE RANGE δ	MAX ALLOWABLE FORCE PER SEISMIC BRACE ASSEMBLY, Fp		
	WPL	SPC (STL*)	SPC (CI**)
30° - 45°	590 LBS	300 LBS	270 LBS
46° - 60°	410 LBS	300 LBS	270 LBS

* STL = STEEL PIPING
** CI = CAST IRON PIPING

NOTES:
1. REF. SECTION A19 OR A20 FOR GENERAL NOTES.
2. PROVIDE ROD STIFFENING ONLY WHERE SEISMIC BRACKETS ARE ATTACHED TO THE ROD AND ROD LENGTH (L) EXCEEDS 31". REF. APPROPRIATE M19 PAGES FOR DETAIL.
3. WHEN THE BRACE IS INSTALLED INSIDE OF THE BRACE BRACKET, ONLY THE CENTER MOUNTING HOLE IS REQUIRED TO BE FASTENED, REF X2.3 FOR CONNECTION DETAILS.
4. FOR PIPE/CONDUIT SIZES UP TO 5"Ø MAX, USE RESPECTIVE MW-SPC SIZE (REF. X2.3-X8.3.1) OR USE MW-WPL-83 (REF. X8.4).
5. REF. SECTION A15 OR A25 FOR ALTERNATIVE ARRANGEMENT OF SEISMIC BRACES.
6. REF. PAGE A19.0 OR A20.0 FOR PIPE/CONDUIT CLAMP OPTION.

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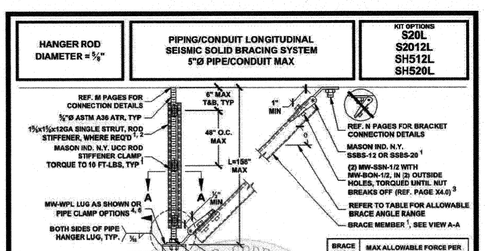
PAGE C1.30

12/19/2016 OPM-0043-13: Reviewed for Code Compliance by Jeffrey Kikumoto Page 203 of 673

HANGER ROD DIAMETER = ⅝" — PIPING/CONDUIT LONGITUDINAL SEISMIC SOLID BRACING SYSTEM 5"Ø PIPE/CONDUIT MAX

KIT OPTIONS: S20L, S2012L, SH512L, SH520L



BRACE ANGLE RANGE δ	MAX ALLOWABLE FORCE PER SEISMIC BRACE ASSEMBLY, Fp		
	WPL	SPC (STL*)	SPC (CI**)
30° - 45°	590 LBS	590 LBS	590 LBS
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* STL = STEEL PIPING
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NOTES:
1. REF. SECTION A19 OR A20 FOR GENERAL NOTES.
2. PROVIDE ROD STIFFENING ONLY WHERE SEISMIC BRACKETS ARE ATTACHED TO THE ROD AND ROD LENGTH (L) EXCEEDS 31". REF. APPROPRIATE M19 PAGES FOR DETAIL.
3. WHEN THE BRACE IS INSTALLED INSIDE OF THE BRACE BRACKET, ONLY THE CENTER MOUNTING HOLE IS REQUIRED TO BE FASTENED, REF X2.3 FOR CONNECTION DETAILS.
4. FOR PIPE/CONDUIT SIZES UP TO 5"Ø MAX, USE RESPECTIVE MW-SPC SIZE (REF. X8.3-X8.3.1) OR USE MW-WPL-83 (REF. X8.4).
5. REF. PAGE A19.0 OR A20.0 FOR PIPE/CONDUIT CLAMP OPTION.

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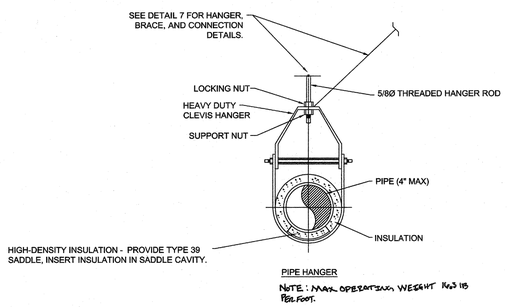
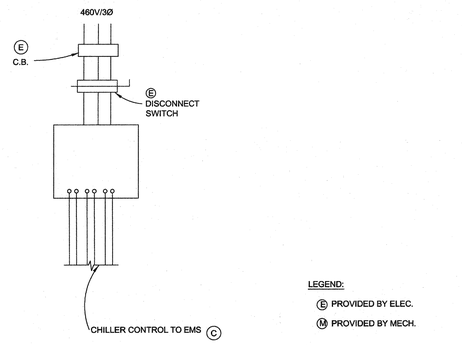
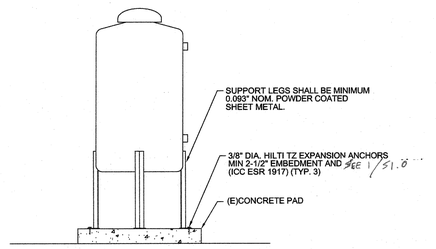
TYPICAL PIPE SUPPORT DETAIL — SCALE NONE — 6



CHILLER WIRING DIAGRAM — SCALE NONE — 5

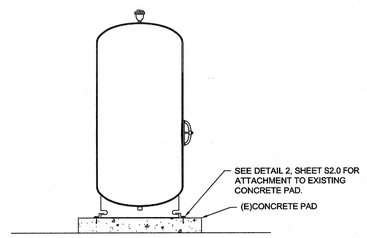


TYP. CHEMICAL POT FEEDER ANCHORAGE DETAIL — SCALE NONE — 4



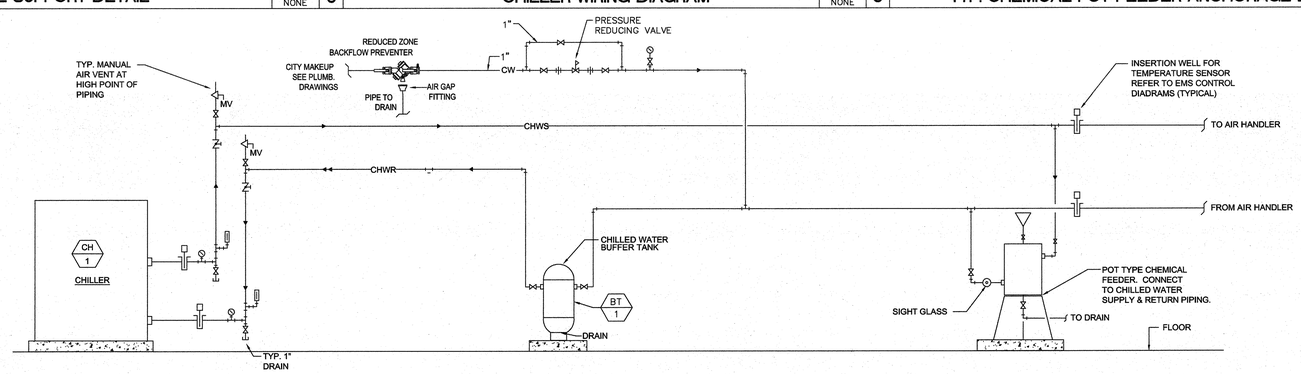
CPF 1 — 100 LB

TYPICAL BUFFER TANK ANCHORAGE DETAIL — SCALE NONE — 3

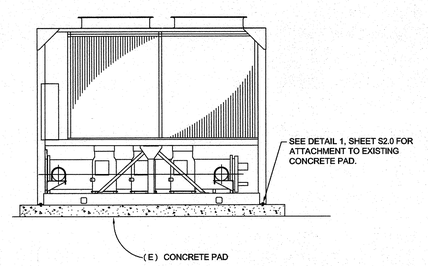


BT 1 — 5,100 LB

CHILLED WATER SYSTEM PIPING DIAGRAM — SCALE NONE — 2



TYPICAL CHILLER ANCHORAGE DETAIL — SCALE NONE — 1



CH 1 — MAX WEIGHT: 6,300 LBS.

12/30/2015 9:39:00 AM File Path

CONSTRUCTION DOCUMENTS

GLENDALE UNIFIED SCHOOL DISTRICT

MUIR ELEMENTARY SCHOOL - CHILLER UPGRADE

912 S. CHEVY CHASE DR. GLENDALE, CA 91205

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APPL NO. 03-118364
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DATE FEB 07 2018

PDS Pocock Design Solutions Inc.

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DRAWN PM
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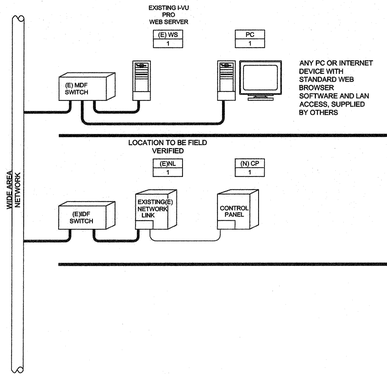
DATE 01-16-2018

MECHANICAL DETAILS

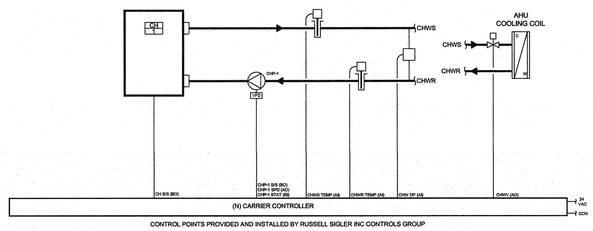
M3.01

WIRE LEGEND			
LINE STYLE	WIRE TYPE	PART NUMBER	DESCRIPTION
	LOCAL AREA NETWORK (CAT 5)		PROVIDED AND INSTALLED BY OTHERS
	BACNET MS/TP NETWORK WIRING	0042002-S	24 AWG 2 COND SHIELDED, PLENUM, ORG
	CARRIER COMFORT NETWORK WIRING	003336-S	20 AWG 3 COND SHIELDED, PLENUM, WHT / GRN STRIPE



EMCS RISER DIAGRAM

SCALE NONE 2



CONTROL POINTS PROVIDED AND INSTALLED BY RUSSELL SIGLER INC CONTROLS GROUP

Sequence of Operations

Chiller System Run Conditions:
The equipment will run according to the following user selectable modes:

-- 1. -- Off:
The equipment will not run and all outputs will remain in their off position.

-- 2. -- via Linkage:
The equipment will run whenever linkage is active and a definable number of chilled water coils need cooling. If linkage is not active, then the equipment will run according to sequence mode number 5 (as outlined below).

-- 3. -- via Outside Air Temperature:
The equipment will run whenever the outside air temperature is greater than 54°F (adj.).

-- 4. -- via Schedule:
The equipment will run whenever scheduled.

-- 5. -- via Outside Air Temperature and Schedule:
The equipment will run whenever the outside temperature is above its user definable threshold (shown above) and whenever it is scheduled. Both conditions must be true for the unit to run.

Chilled Water Pump:
The chilled water pump will run anytime the chilled water system is called to run.
The chilled water pump will start prior to the chiller being enabled and will stop only after the chiller is disabled.

Chilled Water Differential Pressure Control:
The controller will measure chilled water differential pressure and modulate the chilled water pump VFD to maintain its chilled water differential pressure setpoint.

Chiller Chilled Water Supply Setpoint:
The chiller will maintain a chilled water supply temperature setpoint as determined by its own internal controls (provided by others).

Chilled Water Temperature Monitoring:
The following temperatures will be monitored:

- Chilled water supply.
- Chilled water return.

Cooling Coil Valve:
The controller will modulate the cooling coil valve to maintain the cold deck setpoint (adjustable).

CHILLER CONTROL DETAIL

SCALE NONE 1

12/30/2015 9:39:00 File Path
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CONSTRUCTION DOCUMENTS

GLENDALE UNIFIED SCHOOL DISTRICT

MUIR ELEMENTARY SCHOOL - CHILLER UPGRADE

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MECHANICAL DETAILS

M3.02

STATE OF CALIFORNIA
MECHANICAL SYSTEMS
CEC-NRCC-MCH-01-E (Revised 01/16) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE	NRCC-MCH-01-E
Mechanical Systems	(Page 3 of 4)
Project Name: Muir Elementary School Chiller Replacement	Date Prepared: 8/3/2017

C. MECHANICAL HVAC ACCEPTANCE FORMS (check box for required compliance documents)

Test Performed By:

Designer:
This compliance document is to be used by the designer and attached to the plans. Listed below are all the acceptance tests for HVAC systems. The designer is required to check the applicable boxes for all acceptance tests that apply and list all equipment that requires an acceptance test. All equipment of the same type that requires a test, list the equipment description and the number of systems.

Installing Contractor:
The contractor who installed the equipment is responsible to either conduct the acceptance test themselves or have a qualified entity run the test for them. If more than one person has responsibility for the acceptance testing, each person shall sign and submit the Certificate of Acceptance applicable to the portion of the construction or installation for which they are responsible.

Enforcement Agency:
Plancheck – The NRCC-MCH-01-E compliance document is not considered a completed document and is not to be accepted by the building department unless the correct boxes are checked.
Inspector - Before occupancy permit is granted all newly installed process systems must be tested to ensure proper operations.

Test Description		MCH-12-A	MCH-13-A	MCH-14-A	MCH-15-A	MCH-16-A	MCH-17-A	MCH-18-A
Equipment Requiring Testing or Verification	# of Units	Fault Detection & Diagnostics for DX Units	Automatic Fault Detection & Diagnostics for Air & Zone	Distributed Energy Storage DX AC Systems	Thermal Energy Storage (TES) Systems	Supply Air Temperature Reset Controls	Condenser Water Reset Controls	ECMS
CH-1	1	☐	☐	☐	☐	☐	☐	☒
		☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐

STATE OF CALIFORNIA
MECHANICAL SYSTEMS
CEC-NRCC-MCH-01-E (Revised 01/16) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE	NRCC-MCH-01-E
Mechanical Systems	(Page 2 of 4)
Project Name: Muir Elementary School Chiller Replacement	Date Prepared: 8/3/2017

B. MECHANICAL HVAC ACCEPTANCE FORMS (check box for required compliance documents)

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Enforcement Agency:
Plancheck – The NRCC-MCH-01-E compliance document is not considered a completed document and is not to be accepted by the building department unless the correct boxes are checked.
Inspector - Before occupancy permit is granted all newly installed process systems must be tested to ensure proper operations.

Test Description		MCH-02-A	MCH-03-A	MCH-04-A	MCH-05-A	MCH-06-A	MCH-07-A	MCH-08-A	MCH-09-A	MCH-10-A	MCH-11-A
Equipment Requiring Testing or Verification	# of Units	Outdoor Air	Single Zone Unitary	Air Distribution Ducts	Economizer Controls	Demand Control Ventilation (DCV)	Supply Fan VAV	Valve Leakage Test	Supply Water Temp. Reset	Hydronic System Variable Flow Control	Automatic Demand Shed Control
CH-1	1	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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STATE OF CALIFORNIA
MECHANICAL SYSTEMS
CEC-NRCC-MCH-01-E (Revised 01/16) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE	NRCC-MCH-01-E
Mechanical Systems	(Page 1 of 4)
Project Name: Muir Elementary School Chiller Replacement	Date Prepared: 8/3/2017

A. MECHANICAL COMPLIANCE DOCUMENTS & WORKSHEETS (check box if worksheet is included)

For detailed instructions on the use of this and all Energy Efficiency Standards compliance forms, refer to the 2016 Nonresidential Manual
Note: The Enforcement Agency may require all forms to be incorporated onto the building plans.

YES	NO	Comp. Doc./Worksheet #	Title
☑	☐	NRCC-MCH-01-E (Part 1 of 3)	Certificate of Compliance, Declaration. Required on plans for all submittals.
☑	☐	NRCC-MCH-01-E (Part 2 of 3)	Certificate of Compliance, Required Acceptance Tests (MCH-02-A to 11-A). Required on plans for all submittals.
☑	☐	NRCC-MCH-01-E (Part 3 of 3)	Certificate of Compliance, Required Acceptance Tests (MCH-12-A to 18-A). Required on plans where applicable.
☑	☐	NRCC-MCH-02-E (Part 1 of 2)	Mechanical Dry Equipment Summary is required for all submittals with Central Air Systems. It is optional on plans.
☑	☐	NRCC-MCH-02-E (Part 2 of 2)	Mechanical Wet Equipment Summary is required for all submittals with chilled water, hot water or condenser water systems. It is optional on plans.
☐	☑	NRCC-MCH-03-E	Mechanical Ventilation and Reheat is required for all submittals with multiple zone heating and cooling systems. It is optional on plans.
☐	☑	NRCC-MCH-07-E (Part 1 of 2)	Power Consumption of Fans. Required on plans where applicable
☐	☑	NRCC-MCH-07-E (Part 2 of 2)	Power Consumption of Fans, Declaration. Required on plans where applicable

STATE OF CALIFORNIA
HVAC SYSTEM REQUIREMENTS
CEC-NRCC-MCH-02-E (Revised 06/14) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE	NRCC-MCH-02-E
HVAC Wet System Requirements	(Page 3 of 3)
Project Name: Muir Elementary School Chiller Replacement	Date Prepared: 8/3/2017

DOCUMENTATION AUTHOR'S DECLARATION STATEMENT

1. I certify that this Certificate of Compliance documentation is accurate and complete.

Documentation Author Name: Andrew Gossman	Documentation Author Signature: Andrew Gossman
Company: Pocock Design Solutions, Inc.	Signature Date: 8/3/2017
Address: 14451 Chambers Rd. Ste. 210	CEA/ HERS Certification Identification (if applicable): M35839
City/State/Zip: Tustin, CA 92780	Phone: 949-417-3903

RESPONSIBLE PERSON'S DECLARATION STATEMENT

I certify the following under penalty of perjury, under the laws of the State of California:
1. The information provided on this Certificate of Compliance is true and correct.
2. I am eligible under Division 3 of the Business and Professions Code to accept responsibility for the building design or system design identified on this Certificate of Compliance (responsible designer).
3. The energy features and performance specifications, materials, components, and manufactured devices for the building design or system design identified on this Certificate of Compliance conform to the requirements of Title 24, Part 1 and Part 6 of the California Code of Regulations.
4. The building design features or system design features identified on this Certificate of Compliance are consistent with the information provided on other applicable compliance documents, worksheets, calculations, plans and specifications submitted to the enforcement agency for approval with this building permit application.
5. I will ensure that a completed signed copy of this Certificate of Compliance shall be made available with the building permit(s) issued for the building, and made available to the enforcement agency for all applicable inspections. I understand that a completed signed copy of this Certificate of Compliance is required to be included with the documentation the builder provides to the building owner at occupancy.

Responsible Designer Name: Andrew Gossman	Responsible Designer Signature: Andrew Gossman
Company : Pocock Design Solutions, Inc.	Date Signed: 8/3/2017
Address: 14451 Chambers Rd. Ste 210	License: M35839
City/State/Zip: Tustin, CA 92780	Phone: 949-417-3903

STATE OF CALIFORNIA
HVAC DRY & WET SYSTEM REQUIREMENTS
CEC-NRCC-MCH-02-E (Revised 01/16) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE	NRCC-MCH-02-E
HVAC Dry & Wet System Requirements	(Page 2 of 3)
Project Name: Muir Elementary School Chiller Replacement	Date Prepared: 8/3/2017

B. Equipment Tags and System Description[1] – Wet Systems

MANDATORY MEASURES	***T-24 Sections***	***Reference to the Requirements in the Contract Documents[2]***		
Heating Hot Water Equipment Efficiency[3]	110.1	N/A		
Cooling Chilled and Condenser Water Equipment Efficiency[3]	110.1, 140.4(i)	M0.01		
Open and Closed Circuit Cooling Towers conductivity or flow-based controls	110.2(e) 1	N/A		
Open and Closed Circuit Cooling Towers Maximum Achievable Cycles of Concentration (LSI)[6]	110.2(e) 2	N/A		
Open and Closed Circuit Cooling Towers Flow Meter with analog output	110.2(e) 3	N/A		
Open and Closed Circuit Cooling Towers Overflow Alarm	110.2(e) 4	N/A		
Open and Closed Circuit Cooling Towers Efficient Drift Eliminators	110.2(e) 5	N/A		
Pipe Insulation	120.3	SPEC 230719		
PRESCRIPTIVE MEASURES				
Cooling Tower Fan Controls	140.4(h)2, 140.4(h)5	Y/N	Y/N	Y/N
Cooling Tower Flow Controls	140.4(h)3	N/A		
Centrifugal Fan Cooling Towers[4]	140.4(h)4	N/A		
Air-Cooled Chiller Limitation[5]	140.4(j)	Y		
Variable Flow System Design	140.4(k)	Y		
Chiller and Boiler Isolation	140.4(k)	N/A		
CHW and HHW Reset Controls	140.4(k)	Y		
WLHP Isolation Valves	140.4(k)	N/A		
VSD on CHW, CW & WLHP Pumps >5HP	140.4(k)	Y		
DP Sensor Location	140.4(k)	Y		

Notes:
1. Provide equipment tags (e.g. CH 1 to 3) or system description (e.g. CHW loop) as appropriate. Multiple units with common requirements can be grouped together.
2. Provide references to plans (i.e. Drawing Sheet Numbers) and/or specifications (including Section name/number and relevant paragraphs) where each requirement is specified. Enter "N/A" if the requirement is not applicable to this system.
3. The referenced plans and specifications must include all of the following information: equipment tag, equipment nominal capacity, Title 24 minimum efficiency requirements, and actual rated equipment efficiencies. Where multiple efficiency requirements are applicable (e.g. full- and part-load) include all. For chillers operating at non-standard efficiencies provide the Kadj values. For chillers also note whether the efficiencies are Path A or Path B.
4. Identify if cooling towers have propeller fans. If towers use centrifugal fans document which exception is used.
5. If air-cooled chillers are used, document which exceptions have been used to comply with 140.4(j) and the total installed design capacity of the air-cooled chillers in the chilled water plant.
6. Identify the existence of a completed MCH-06-E when open or closed circuit cooling towers are specified to be installed, otherwise enter "N/A".

STATE OF CALIFORNIA
HVAC DRY & WET SYSTEM REQUIREMENTS
CEC-NRCC-MCH-02-E (Revised 01/16) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE	NRCC-MCH-02-E
HVAC Dry & Wet System Requirements	(Page 1 of 3)
Project Name: Muir Elementary School Chiller Replacement	Date Prepared: 8/3/2017

A. Equipment Tags and System Description[1] – Dry Systems

MANDATORY MEASURES	***T-24 Sections***	***Reference to the Requirements in the Contract Documents[2]***		
Heating Equipment Efficiency[3]	110.1 or 110.2(a)	N/A		
Cooling Equipment Efficiency[3]	110.1 or 110.2(a)	N/A		
HVAC or Heat Pump Thermostats	110.2(b), 110.2(c)	N/A		
Furnace Standby Loss Control	110.2(d)	N/A		
Low Leakage AHUs	110.2(f)	N/A		
Ventilation[4]	120.1(b)	N/A		
Demand Control Ventilation[5]	120.1(c)4	N/A		
Occupant Sensor Ventilation Control[6]	120.1(c)5, 120.2(e)3	N/A		
Shutoff and Reset Controls[7]	120.2(e)	N/A		
Outdoor Air and Exhaust Damper Control	120.2(f)	N/A		
Isolation Zones	120.2(g)	N/A		
Automatic Demand Shed Controls	120.2(h)	N/A		
Economizer FDD	120.2(i)	N/A		
Duct Insulation	120.4	N/A		
PRESCRIPTIVE MEASURES				
Equipment is sized in conformance with 140.4(a & b)	140.4(a & b)	Y/N	Y/N	Y/N
Supply Fan Pressure Control	140.4(c)	N/A		
Simultaneous Heat/Cool[8]	140.4(d)	N/A		
Economizer	140.4(e)	N/A		
Heat and Cool Air Supply Reset	140.4(f)	N/A		
Electric Resistance Heating[9]	140.4(g)	N/A		
Duct Leakage Sealing and Testing[10]	140.4(l)	N/A		

Notes:
1. Provide equipment tags (e.g. AHU 1 to 10) and system description (e.g. Single Duct VAV reheat) as appropriate. Multiple units with common requirements can be grouped together.
2. Provide references to plans (i.e. Drawing Sheet Numbers) and/or specifications (including Section name/number and relevant paragraphs) where each requirement is specified. Enter "N/A" if the requirement is not applicable to this system.
3. The referenced plans and specifications must include all of the following information: equipment tag, equipment nominal capacity, Title 24 minimum efficiency requirements, and actual rated equipment efficiencies. Where multiple efficiency requirements are applicable (e.g. full- and part-load) include all. Where appliance standards apply (110.1), identify where equipment is required to be listed per Title 20 1601 et seq.
4. Identify where the ventilation requirements are documented for each central HVAC system. Include references to both central unit schedules and sequences of operation. If one or more spaces is naturally ventilated identify where this is documented in the plans and specifications. Multiple zone central air systems must also provide a MCH-03-E compliance document.
5. If one or more spaces has demand controlled ventilation identify where it is specified including the sensor specifications and the sequence of operation.
6. If one or more space has occupant sensor ventilation control identify where it is specified including the sensor specifications and the sequence of operation
7. If the system is DDC identify the sequences for the system start/stop, optimal start, setback (if required) and setup (if required). For all systems identify the specification for the thermostats and time clocks (if applicable).
8. Identify where the heating, cooling and deadband airflows are scheduled for this system. Include a reference to the specification of the zone controls. Provide a MCH-03-E compliance document.
9. Enter N/A if there is no electric heating. If the system has electric heating indicate which exception to 140.4(g) applies.
10. If duct leakage sealing and testing is required, a MCH-04-A compliance document must be submitted.

STATE OF CALIFORNIA
MECHANICAL SYSTEMS
CEC-NRCC-MCH-01-E (Revised 01/16) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE	NRCC-MCH-01-E
Mechanical Systems	(Page 4 of 4)
Project Name: Muir Elementary School Chiller Replacement	Date Prepared: 8/3/2017

DOCUMENTATION AUTHOR'S DECLARATION STATEMENT

1. I certify that this Certificate of Compliance documentation is accurate and complete.

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Responsible Designer Name: Andrew Gossman	Responsible Designer Signature: Andrew Gossman
Company : Pocock Design Solutions, Inc.	Date Signed: 8/3/2017
Address: 14451 Chambers Rd. Ste 210	License: M35839
City/State/Zip: Tustin, CA 92780	Phone: 949-417-3903

CONSTRUCTION DOCUMENTS

GLENDALE UNIFIED SCHOOL DISTRICT

IDENTIFICATION STAMP
DIVISION OF STATE ARCHITECT
OFFICE OF REGULATION SERVICES
FILE NO. 19-41
APPL NO. 03-118364
AC ✓ FLS ES SS VC
DATE FEB 07 2018

PDS
PocockDesignSolutions Inc.

GLENDALE UNIFIED SCHOOL DISTRICT
MUIR ELEMENTARY SCHOOL - CHILLER UPGRADE
912 S. CHEVY CHASE DR,
GLENDALE, CA 91205

REGISTERED PROFESSIONAL ENGINEER
ANDREW R. GOSSMAN
No. M35839
Exp. 3/31/18
MECHANICAL
STATE OF CALIFORNIA

NAC ARCHITECTURE
nacarchitecture.com
837 NORTH SPRING STREET, THIRD FLOOR
LOS ANGELES CA 90012
P: 323.475.8075

NAC NO	161–17036
DRAWN	PM
CHECKED	AG
DATE	01–16–2018

TITLE 24 FORMS

M4.01

12/30/2015 9:39:00 AM File Path

GENERAL NOTES

1. ALL ELECTRICAL WORK SHALL CONFORM TO 2016 CBC STATE ELECTRICAL CODES. CODES ENFORCED BY THE AUTHORITY HAVING JURISDICTION AND DSA REQUIREMENTS. ALL ELECTRICAL MATERIAL AND EQUIPMENT SHALL BE UL LISTED.
2. MINIMUM WIRE SIZE FOR LINE VOLTAGE WIRING SHALL BE #12 AWG, 600 VOLT "THHW" OR "THHN" INSULATION, COPPER CONDUCTORS. WIRING FOR SIGNAL AND FIRE ALARM SYSTEMS SHALL BE AS NOTED ON THE DRAWINGS.
3. ALL CONDUIT SIZES SHALL CONFORM TO THE NATIONAL ELECTRICAL CODE FOR CONDUIT FILL.
4. THE SEISMIC ANCHORAGE OF ELECTRICAL EQUIPMENT SHALL CONFORM TO CCR, TITLE 24, 2016 CBC SECTION 1632A AND TABLE 16A-0.
5. ALL CONDUIT, WIRE, DEVICES, AND BOXES ARE NEW UNLESS NOTED OTHERWISE.
6. THE CONTRACTOR SHALL VERIFY ALL CONDITIONS AT THE JOB SITE PRIOR TO SUBMITTING BID.
7. CONTRACTOR SHALL FURNISH AND INSTALL COMPLETE SYSTEMS AT THE SITE. THE SYSTEMS SHALL INCLUDE; ALL EQUIPMENT, CONDUIT CABLE, WIRE AND ALL NECESSARY ITEMS FOR THE SYSTEM TO BE OPERABLE.
8. PATCH ALL EXISTING WALLS AS NECESSARY. MATERIAL, WORKMANSHIP AND FINISH SHALL MATCH EXISTING.
9. THE CONTRACTOR SHALL OBTAIN AND PAY FOR ALL PERMITS AND INSPECTIONS WHICH ARE REQUIRED FOR THE ELECTRICAL WORK BY LEGALLY CONSTITUTED AUTHORITIES, AND SHALL DELIVER ALL CERTIFICATES TO THE DISTRICTS FACILITIES BRANCH BEFORE THE WORK IS STARTED.
10. ALL RUNS OF CONDUIT ONLY SHALL HAVE AN IDEAL CAT. #31-343 "POWER-FISH" PULL LINE INSTALLED.
11. THE DRAWINGS INDICATE THE ELECTRICAL WORK WHICH IS TO BE IN PLACE WHEN THE WORK IS COMPLETE.
12. NO CABLE SHALL BE INSTALLED PRIOR TO THE INSPECTION AND ACCEPTANCE OF A COMPLETED CONDUIT SYSTEM.
13. EXISTING CIRCUITS, CONDUIT RUNS AND OUTLET LOCATION HAVE BEEN DEVELOPED FROM THE BEST INFORMATION AVAILABLE TO THE DISTRICT AT THE TIME THE DRAWINGS WERE PREPARED. THE DISTRICT PROVIDES THIS ONLY AS A GENERAL GUIDELINE FOR THE CONVENIENCE OF BUILDERS/CONTRACTORS AND DOES NOT GUARANTEE OR WARRANT IN ANY WAY EXPRESSLY OR IMPLIED THE ACCURACY OF THESE REPRESENTATIONS. NOTHING IN THE DISCLAIMER AFFECTS THE CONTRACTORS RESPONSIBILITY TO PROVIDE ACCURATE "AS-BUILT" DRAWINGS AFTER THE COMPLETION OF THE CONTRACT.
14. AT NO TIME DURING CONSTRUCTION AND INSTALLATION MODIFICATION OF THE FIRE ALARM SYSTEM SHALL THE SCHOOL BE WITHOUT AN OPERATIONAL FIRE ALARM SYSTEM WHEN CHILDREN ARE ON CAMPUS. CHANGE OVERS MUST BE DONE AFTER SCHOOL OR ON THE WEEKENDS. THE CONTRACTOR SHALL NOTIFY THE SCHOOL SITE PERSONAL AND THE MAINTENANCE OFFICE 48 HOURS PRIOR TO ANY DISCONNECTION OR CHANGE OVER OF THE FIRE ALARM SYSTEM, OR A FIRE WATCH WILL BE REQUIRED. CBC CHAPTER 34 AND CHAPTER 14 CFC.
15. THE TERM "PULL" USED ON THE DRAWINGS SHALL BE CONSIDERED TO MEAN "FURNISH, INSTALL AND CONNECT".
16. ALL EQUIPMENT SHALL BE LISTED BY AN APPROVED TESTING AGENCY PER SPECIFICATIONS. IN ADDITION, ALL FIRE ALARM AND DETECTION EQUIPMENT SHALL BE LISTED BY THE CALIFORNIA STATE FIRE MARSHAL (CSFM).
17. ALL NEW CONDUITS INSTALLED UNDER THIS SECTION OF WORK SHALL BE 3/4 INCH MINIMUM SIZE, EXCEPT "WHIPS" TO FLUORESCENT FIXTURES IN SUSPENDED CEILING. FIXTURE "WHIPS" MAY BE 1/2" CONDUIT TO FLUORESCENT FIXTURES IN SUSPENDED CEILING.
18. IT SHALL BE THE CONTRACTORS RESPONSIBILITY TO PATCH AND REPAIR ALL DAMAGE TO EXISTING FINISHES. THE AREAS OF WORK SHALL BE REPAIRED TO THE FINISH EXISTING PRIOR TO THE COMMENCEMENT OF WORK.
19. CONTRACTOR SHALL INSTALL NEW BLANK PLATES ON ALL EXISTING FLUSH OUTLETS THAT ARE ABANDONED IN PLACE. CONTRACTOR SHALL VERIFY LOCATION OF ALL ABANDONED OUTLETS AND SHALL INSTALL NEW PLATES ON ALL - EVEN THOSE NOT INDICATED OR NOTED SPECIFICALLY ON THE DRAWINGS.
20. ALL NEW OUTLETS (FOR RECEPTACLES, SWITCHES, J-BOXES, ETC.) INSTALLED IN EXISTING WALLS SHALL BE "CUT-IN" TYPE BOXES WITH FLEXIBLE CONDUIT "FISHED" INTO WALL CAVITY FROM CEILING SPACE ABOVE. ON EXISTING MASONRY WALLS (OR OTHER INACCESSIBLE TYPE WALLS) NEW OUTLETS SHALL BE SURFACE RACEWAY TYPE WITH EXPOSED SURFACE RACEWAY (WIREMOLD) OF APPROPRIATE SIZE. OBTAIN ARCHITECTS APPROVAL FOR ALL SURFACE RACEWAY LOCATIONS.
21. PLUG ALL KNOCK-OUTS WHERE CONDUITS ARE REMOVED FROM EXISTING BOXES, PANELS, SWITCHBOARDS, ENCLOSURES, ETC.
22. WHERE HVAC AND PLUMBING EQUIPMENT IS SHOWN ON ELECTRICAL DRAWINGS, IT IS FOR REFERENCE ONLY. SEE MECHANICAL DRAWINGS FOR EXACT SIZE, LOCATION, CONNECTIONS, ETC. OF ALL EQUIPMENT. ALL WORK DESIGNATED AS "ELECTRICAL" ON MECHANICAL/ PLUMBING DRAWINGS SHALL BE DONE AS IF SHOWN ON THESE PLANS. VERIFY ALL LOCATIONS OF MECHANICAL EQUIPMENT WITH APPROPRIATE CONTRACTORS.
23. THE CONTRACTOR IS RESPONSIBLE FOR SEALING ALL FIRE RATED PENETRATIONS WHETHER INDICATED OR NOT.
24. IF THE CONTRACTOR BELIEVES THAT THERE ARE CONFLICTS WITHIN THESE ELECTRICAL DRAWINGS OR BETWEEN THE ELECTRICAL DRAWINGS AND THE SPECIFICATIONS, OR BETWEEN THE ELECTRICAL DRAWINGS AND ANY MECHANICAL, ARCHITECTURAL, PLUMBING OR STRUCTURAL DRAWING, BID THE MORE EXPENSIVE OR ELABORATE PROCESS OR PROCEDURE SHOWN AND CALL THE DISCREPANCY TO THE ARCHITECT'S ATTENTION. SHOULD THE DISTRICT, IN ITS DISCRETION, CHOOSE TO IMPLEMENT THE CHEAPER OR SIMPLER PROCEDURE AFTER BID OPENING, A CREDIT CHANGE ORDER WILL BE ISSUED TO THE CONTRACTOR.
25. INSTALL ALL CONDUIT BUSHINGS PRIOR TO INSTALLATION OF ANY CONDUCTORS, SEE NOTE #12.
26. THE CONTRACTOR SHALL CAREFULLY REVIEW THE SPECIFICATIONS AS THEY PERTAIN TO RIGID CONDUIT. THE SPECIFICATION REQUIREMENTS ARE VERY STRINGENT AND SUBSTANTIALLY EXCEED MINIMUM CODE REQUIREMENTS. NO DEVIATIONS WILL BE ALLOWED WHERE RIGID CONDUIT IS CALLED FOR.
27. "AS PART OF THE BASIC CONTRACT WORK UNDER THIS PROJECT, IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO LABEL ALL CONDUCTORS WHICH WILL REMAIN AS EXISTING SERVICE AND TO IDENTIFY THESE CIRCUITS ON THE PANEL SCHEDULES PREPARED FOR THE NEW AND EXPANDED PANEL BOXES. THE CONTRACTOR SHALL ALSO, AT NO ADDITIONAL CHARGE, TEST ALL EXISTING CONDUCTORS TO REMAIN TO VERIFY THAT THEY ARE OPERATIONAL AND CONDUCTING THE SPECIFIED VOLTAGE. FOLLOWING THE TESTING PROCEDURE, IDENTIFY ALL NOTED DISCREPANCIES TO THE ATTENTION OF THE ELECTRICAL ENGINEER FOR RESOLUTION."
28. UPON COMPLETION OF THE ELECTRICAL INSTALLATION, PATCH AND PAINT AS REQUIRED TO RESTORE WALLS AND SURFACES TO NEW CONDITION.
29. ALL EXPOSED CONDUIT, PULLBOXES, OUTLET BOXES, ETC. SHALL BE PAINTED TO MATCH SURROUNDING SURFACE. COORDINATE WITH ARCHITECT. REFER TO SPECIFICATION SECTION 09900.
30. ALL DEMOLITION SHALL COMPLY WITH CH. 34 CBC AND CHAPTER 14 CFC.

EQUIPMENT ANCHORAGE NOTES

1. ALL MECHANICAL AND ELECTRICAL EQUIPMENT SHALL BE BRACED OF ANCHORED TO RESIST A HORIZONTAL FORCE ACTING IN ANY DIRECTION USING THE FOLLOWING CRITERIA PER 2016 CBC, AND ASCE 07-10

$$Fp = \frac{.4ap\ S_{DS}\ Wp}{(Rp/Ip)} \quad (1+S\frac{z}{h}) = 1.19Wp$$

WHERE:
- Fp = HORIZONTAL SEISMIC FORCE AT STRENGTH LOAD LEVEL 1.0E
- ap = 2.5 FOR FLEXIBLE EQUIPMENT, INCLUDING EQUIP. ON VIBRATION ISOLATORS
- S_{DS} = 1.875
- Ip = 1.5
- Rp = 6
- h = HEIGHT OF EQUIPMENT ATTACHMENT ABOVE GRADE
- Wp = WEIGHT OF EQUIPMENT

2. Fp SHALL NOT BE LESS THAN $.3S_{DS}$ Ip Wp = 0.71 Wp

   Fp NEED NOT EXCEED $1.6S_{DS}$ Ip Wp = 3.79 Wp
3. ANCHORS MUST MEET REQUIREMENTS OF 2016 CBC SECTION 1616A.1.19.
4. FOR LOAD COMBINATIONS, SEE 2016 CBC.
5. ALL EQUIPMENT SHALL BE DESIGNED FOR A SIMULTANEOUS VERTICAL SEISMIC FORCE EQUAL TO + .20 S Wp = 0.32 Wp
6. ANCHORAGE OF EQUIPMENT SHALL BE PER 2016 CBC AND ASCE 07-10, TABLE 13.6-1 AND SECTION $13.6._{DS}$

SYMBOL LIST

Symbol	Description
(dashed symbols) S	DASHED SYMBOL INDICATES EXISTING FIXTURE, OUTLET, DEVICE OR EQUIPMENT TO BE REMOVED.
(fine-lined symbols) $	FINE-LINED SYMBOL INDICATES EXISTING FIXTURE, OUTLET, DEVICE OR EQUIPMENT TO REMAIN.
—EX—	EXISTING CONDUIT TO BE REUSED.
—R—	EXISTING CONDUIT TO BE REMOVED IF IN AN ACCESSIBLE AREA OR TO BE ABANDONED IF IN AN INACCESSIBLE AREA.
A	FIXTURE TYPE AND WATTAGE PER FIXTURE LIST. TYPICAL FOR ROOM INDICATED UNLESS OTHERWISE NOTED.
11a	INDICATES CONTROLLING SWITCH LEG.
	DENOTES BRANCH CIRCUIT NUMBER SUPPLYING FIXTURE.
	RECESSED MOUNTED FLUORESCENT LIGHTING FIXTURE.
	DUPLEX RECEPTACLE, MOUNTED AT +15" U.O.N.
	DUPLEX RECEPTACLE, GFI PROTECTION AT +15" U.O.N.
	DOUBLE DUPLEX GFI RECEPTACLE MOUNTED AT +15" U.O.N.
	DOUBLE DUPLEX RECEPTACLE, MOUNTED AT +15" U.O.N.
J	FLEXIBLE CONDUIT "FISH" DOWN PARTITION WALL FROM ACCESSIBLE CEILING SPACE TO DEVICE AS INDICATED. DEVICE IS AS INDICATED ON THE PLANS.
	FLUSH MOUNTED PANELBOARD.
	SURFACE MOUNTED PANELBOARD.
	SURFACE MOUNTED CABINET, AS NOTED.
	FLUSH MOUNTED CABINET, AS NOTED.
N	NON-FUSED DISCONNECT SWITCH. SIZE AS NOTED. (NFDS)
	FUSED DISCONNECT SWITCH. SIZE AS NOTED. (FDS)
J	CODE SIZE JUNCTION BOX. 5/S OR LARGER IF REQUIRED FOR NUMBER/SIZE OF CONDUCTORS.
	PULL BOX WITH SCREW COVER, SIZE AS NOTED.
A-1,3	HOMERUN TO INDICATED PANELBOARD ("A"). NUMBERS (1,3) INDICATE BRANCH CIRCUIT NUMBERS.
3/4"-3#8+1#10 EG	INDICATES 3/4" CONDUIT WITH 3 NUMBER 8 CONDUCTORS + 1 NUMBER 10 EQUIPMENT GROUND.
3/4"-3#10+3#10(IN)+1#10 EG	INDICATES 3/4" CONDUIT WITH 3 NUMBER 10 PHASE CONDUCTORS PLUS 3 NUMBER 10 INDIVIDUAL NEUTRAL CONDUCTORS PLUS 1 NUMBER 10 EQUIPMENT GROUND.
(2) 3" 3-500KCM+1#1/0 EG	INDICATES TWO (2) 3" CONDUITS WITH THREE (3) 500 kcmil CONDUCTORS PLUS ONE (1) NUMBER 1/0 EQUIPMENT GROUNDING CONDUCTOR IN EACH CONDUIT.
	3/4" CONDUIT WITH 2#12 CONDUCTORS PLUS 1#12 E.G. CONDUCTOR
	3/4" CONDUIT WITH 3#12 CONDUCTORS PLUS 1#12 E.G. CONDUCTOR
	3/4" CONDUIT WITH 4#12 CONDUCTORS PLUS 1#12 E.G. CONDUCTOR
	3/4" CONDUIT WITH 5#12 CONDUCTORS PLUS 1#12 E.G. CONDUCTOR
	3/4" CONDUIT WITH 6#12 CONDUCTORS PLUS 1#12 E.G. CONDUCTOR
	3/4" CONDUIT WITH 7#12 CONDUCTORS PLUS 1#12 E.G. CONDUCTOR
	1" CONDUIT WITH 8#12 CONDUCTORS PLUS 1#12 E.G. CONDUCTOR
#10	THE NUMBER "10" OR "8" ADJACENT TO THE HASH MARK IN ANY CONDUIT RUN INDICATES #10 (OR #8) CONDUCTORS IN LIEU OF #12 CONDUCTORS. INCREASE CONDUIT SIZE TO ACCOMMODATE QUANTITY OF #10 (OR #8) CONDUCTORS INDICATED. EQUIPMENT GROUND CONDUCTOR SIZE SHALL ALSO INCREASE TO #10 (FOR #10 OR #8 CIRCUIT CONDUCTORS)
S	SPEAKER MOUNTED IN CEILING. REFER TO SPEAKER SCHEDULES FOR SPEAKER TYPE.
S	SPEAKER MOUNTED ON WALL AT HEIGHT INDICATED. REFER TO SPEAKER SCHEDULES FOR SPEAKER TYPE.
A	SECURITY SYSTEM SENSOR
WAP	WIRELESS ACCESS POINT.
	COMBINATION VOICE AND DATA OUTLET INSTALLED IN A FLUSH OUTLET BOX.
2	DATA OUTLET INSTALLED IN A FLUSH OUTLET BOX. NUMBER INDICATES QUANTITY OF JACKS
	VOICE OUTLET INSTALLED IN A FLUSH OUTLET BOX. INSTALL VOICE JACK(S) TO MEET THE SPECIFICATIONS AT EACH LOCATION.
TV	TELEVISION OUTLET - VERIFY EXACT LOCATION WITH ARCHITECTURAL ELEVATIONS
AC 2	MECHANICAL EQUIPMENT REFERENCE.
	CONDUIT CONCEALED IN WALL OR CEILING SPACE.
	CONDUIT CONCEALED UNDERGROUND.
	CONDUIT INSTALLED EXPOSED.
	FLEXIBLE METAL CONDUIT. INSTALL REQUIRED BRANCH CIRCUIT CONDUCTORS AND EQUIPMENT GROUND CONDUCTOR.
	3/4" X 10'-0" ELECTROLYTIC GROUND ROD, U.O.N.
	3/4" X 10'-0" ELECTROLYTIC GROUND ROD IN A YARD BOX.
	CURRENT TRANSFORMER, RATIO AS INDICATED.
KWH	KILOWATT HOUR DEMAND METER.
	DISCONNECT SWITCH.
	LOW VOLTAGE CIRCUIT BREAKER.
	POWER TRANSFORMER.
	GROUND CONNECTION.
100A	TRIP SETTING
225A	FRAME SIZE
3P	NO. OF POLES
4	ELECTRICAL NOTE REFERENCE
C / E-5.0	INDICATES DETAIL "C" ON SHEET 0E-5.0
A, AMP	AMPERE
AC	ALTERNATING CURRENT
AFF	ABOVE FINISHED FLOOR
C.O.	CONDUIT ONLY
EA.	EACH
EG	EQUIPMENT GROUND
EX	EXISTING
FA	FIRE ALARM
FACP	FIRE ALARM CONTROL PANEL
FIB. OP.	FIBER OPTIC
GFI	GROUND-FAULT INTERRUPTER
GWP	GLENDALE WATER & POWER
IACP	INTRUSION ALARM CONTROL PANEL
IDF	INTERMEDIATE DISTRIBUTION FRAME
MDF	MAIN DISTRIBUTION FRAME
LAN	LOCAL AREA NETWORK
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
SCE	SOUTHERN CALIFORNIA EDISON
TYP	TYPICAL
U.O.N.	UNLESS OTHERWISE NOTED
WP	WEATHERPROOF
+48"	MOUNTING HEIGHT ABOVE FINISHED FLOOR TO CENTER OF DEVICE.

BRANCH CIRCUIT VOLTAGE DROP TABLE

MAXIMUM BRANCH CIRCUIT LENGTH (ONE WAY) FOR VOLTAGE DROP LESS THAN 3%

NORMAL VOLTAGE	CIRCUIT RATING	WIRE SIZE (AWG)	MAX LENGTH (FT)	MAX LOAD (VA)	MAX LOAD (AMPS)	VOLTAGE DROP (%)
120 VOLTS	20 AMPS	12	100	1920	16	2.67
		10	180	1920	16	2.88
		8	275	1920	16	2.86
277 VOLTS	20 AMPS	12	250	4432	16	2.89
		10	400	4432	16	2.77
		8	625	4432	16	2.82

CONDUIT SIZING SCHEDULE

CONDUIT SIZE	AREA	40% FILL x 75%	ALLOWABLE FILL
3/4" DIAMETER CONDUIT	.53 S.I.	.53 S.I.	.159 S.I.
1" DIAMETER CONDUIT	.86 S.I.	.86 S.I.	.258 S.I.
1 1/4" DIAMETER CONDUIT	1.50 S.I.	1.50 S.I.	.450 S.I.
1 1/2" DIAMETER CONDUIT	2.04 S.I.	2.04 S.I.	.612 S.I.
2" DIAMETER CONDUIT	3.36 S.I.	3.36 S.I.	1.01 S.I.
2 1/2" DIAMETER CONDUIT	5.86 S.I.	5.86 S.I.	1.76 S.I.
3" DIAMETER CONDUIT	8.85 S.I.	8.85 S.I.	2.66 S.I.
3 1/2" DIAMETER CONDUIT	11.5 S.I.	11.5 S.I.	3.45 S.I.
4" DIAMETER CONDUIT	14.75 S.I.	14.75 S.I.	4.43 S.I.

WORKMANSHIP NOTES

1. AESTHETICS ARE A VERY IMPORTANT COMPONENT OF THIS PROJECT. INSTALLATION OF ALL ELECTRICAL WORK SHALL BE OF THE HIGHEST QUALITY AND CRAFTSMANSHIP POSSIBLE.
2. THE ELECTRICAL DRAWINGS ARE ESSENTIALLY DIAGRAMMATIC TO THE EXTENT THAT MANY OFFSETS, BENDS, SPECIAL FITTINGS AND EXACT LOCATIONS ARE NOT INDICATED. THE CONTRACTOR SHALL CAREFULLY STUDY THE DRAWINGS AND PREMISES IN ORDER TO DETERMINE THE BEST METHODS, EXACT LOCATIONS, ROUTES, OBSTRUCTIONS, ETC. WHICH AFFECT HIS INSTALLATION. REFER TO SPECIFICATION SECTION 16000 FOR ADDITIONAL REQUIREMENTS.
3. ALL NEW CONDUIT SHALL BE INSTALLED CONCEALED IN WALLS, CEILINGS OR UNDERGROUND.
4. ANY EXPOSED CONDUITS/RACEWAYS THAT ARE ALLOWED SHALL BE INSTALLED IN LOCATIONS THAT ARE AS INCONSPICUOUS AS POSSIBLE, AND SHALL FOLLOW THE LINES OF THE STRUCTURE AS CLOSELY AS POSSIBLE. ALL EXPOSED CONDUITS, BOXES, ETC. SHALL BE PAINTED. REFER TO SPECIFICATION SECTION 09900.

ELECTRICAL DRAWING INDEX

CONSTRUCTION DOCUMENTS

IDENTIFICATION STAMP
DIVISION OF STATE ARCHITECT
OFFICE OF REGULATION SERVICES
DATE FEB 07 2018

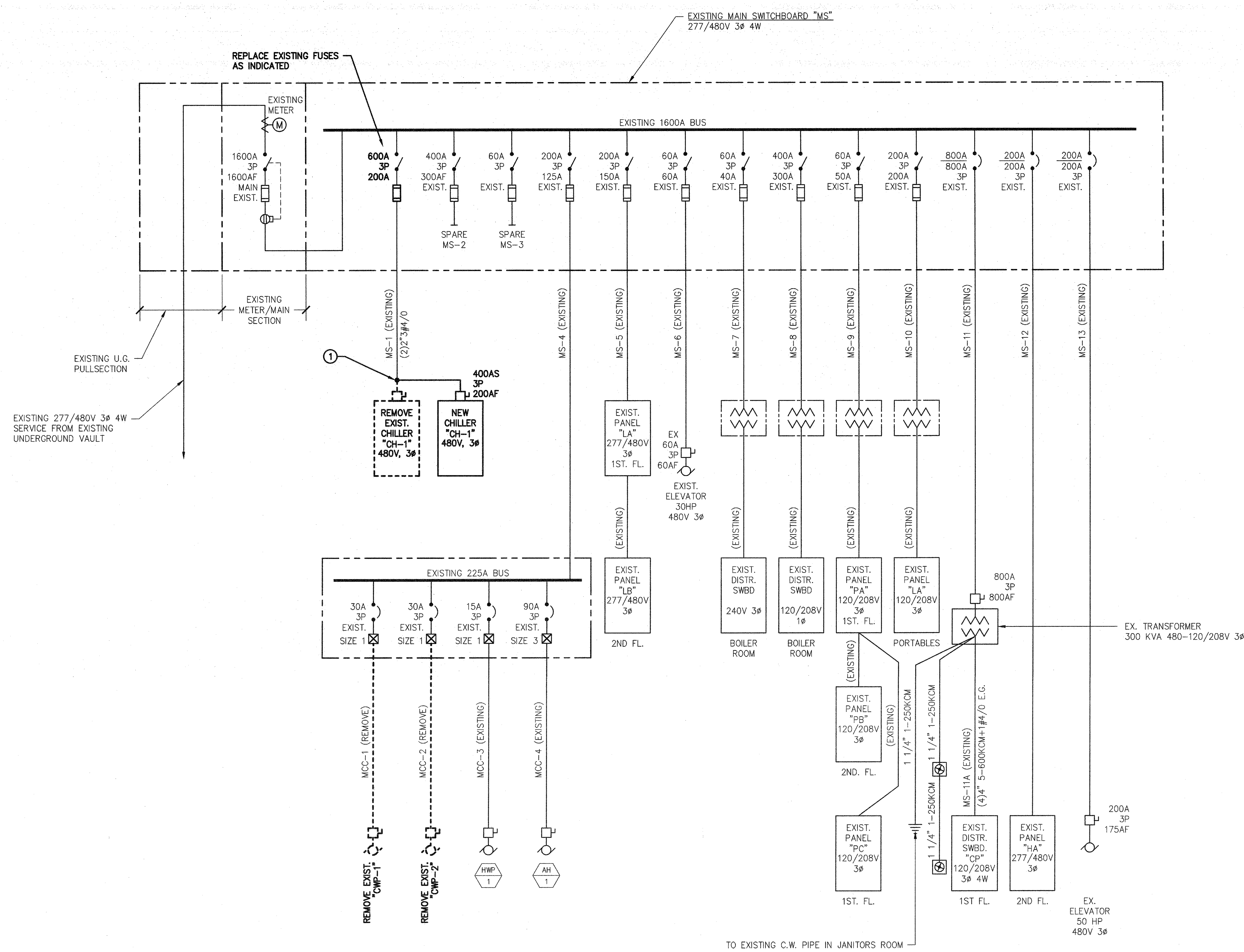
GLENDALE UNIFIED SCHOOL DISTRICT
MUIR ELEMENTARY SCHOOL - CHILLER UPGRADE
912 S. CHEVY CHASE DR, GLENDALE CA 91205

NAC ARCHITECTURE
nacarchitecture.com

NAC NO 161-17036
DRAWN RK
CHECKED JK
DATE 07-26-2017

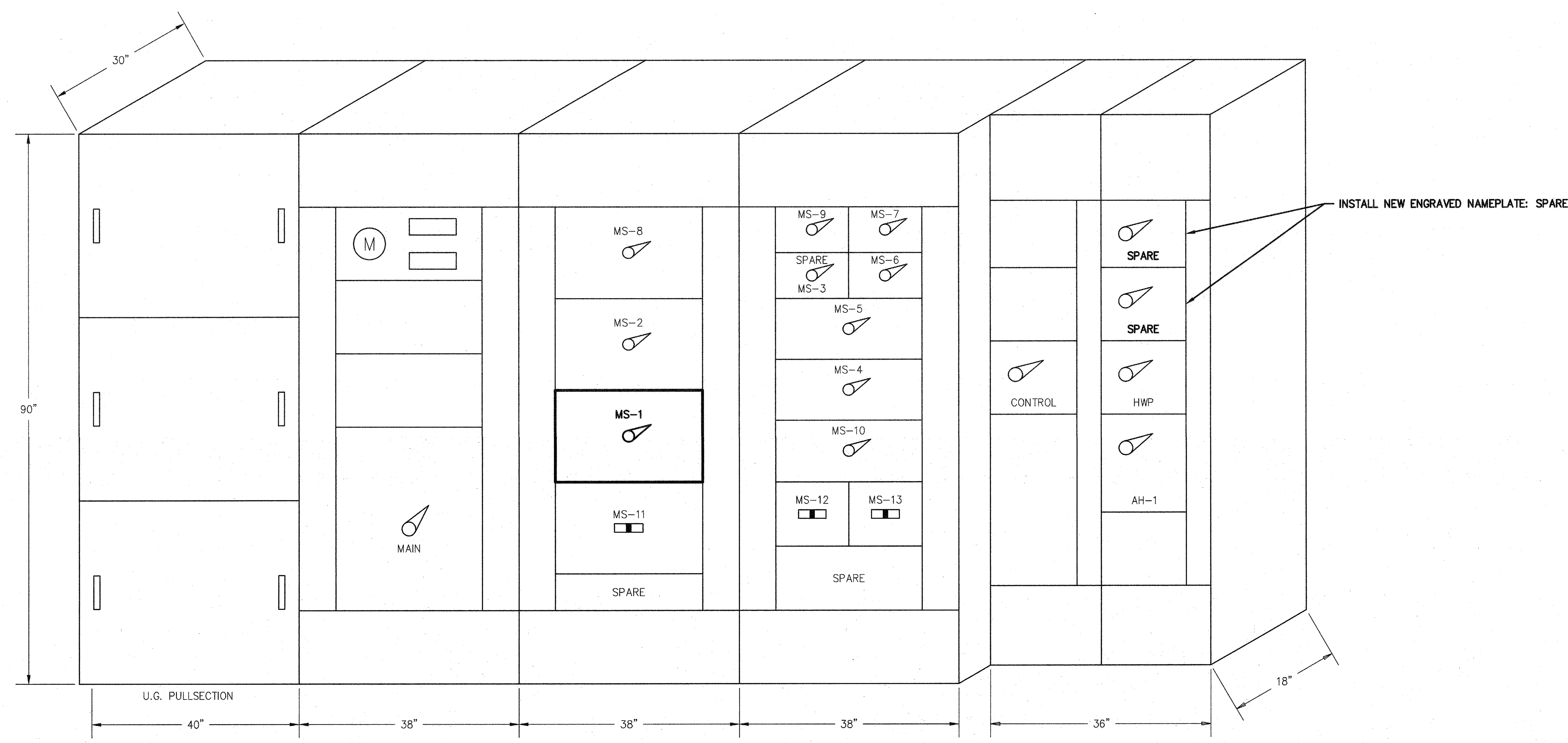
SYMBOL LIST, GENERAL NOTES

E0.01



KEY NOTES - THIS SHEET ONLY

1. INTERCEPT EXISTING FEEDER AT DISCONNECT SWITCH TO BE REMOVED
   - CONNECT EXISTING FEEDER TO NEW DISCONNECT SWITCH AS INDICATED.



ELEVATION - EXISTING MAIN SWITCHBOARD "MS" & MOTOR CONTROL CENTER "MCC"
SCALE: 1" = 1'-0"

CONSTRUCTION DOCUMENTS

IDENTIFICATION STAMP
DIVISION OF STATE ARCHITECT
OFFICE OF REGULATION SERVICES
FILE NO. 19-41
APPL. NO. 03-118364
DATE FEB 07 2018

TURPIN & RATTAN 16371.MD

GLENDALE UNIFIED SCHOOL DISTRICT
MUIR ELEMENTARY SCHOOL - CHILLER UPGRADE
912 S. CHEVY CHASE DR, GLENDALE CA 91205

NAC ARCHITECTURE
nacarchitecture.com
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LOS ANGELES CA 90012

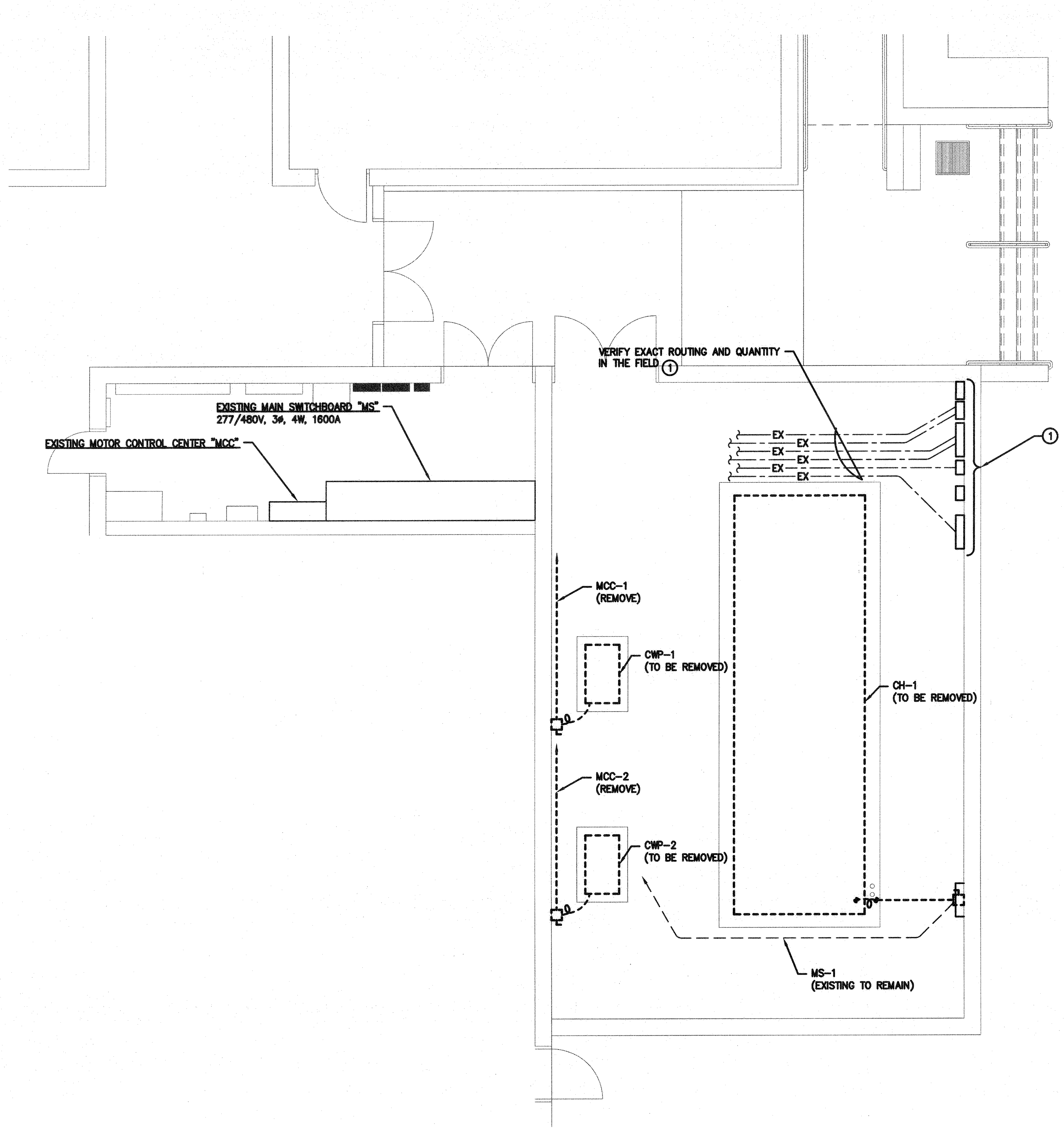
NAC NO	161-17036
DRAWN	RK
CHECKED	JK
DATE	07-26-2017

SINGLE LINE DIAGRAM & ELEVATIONS

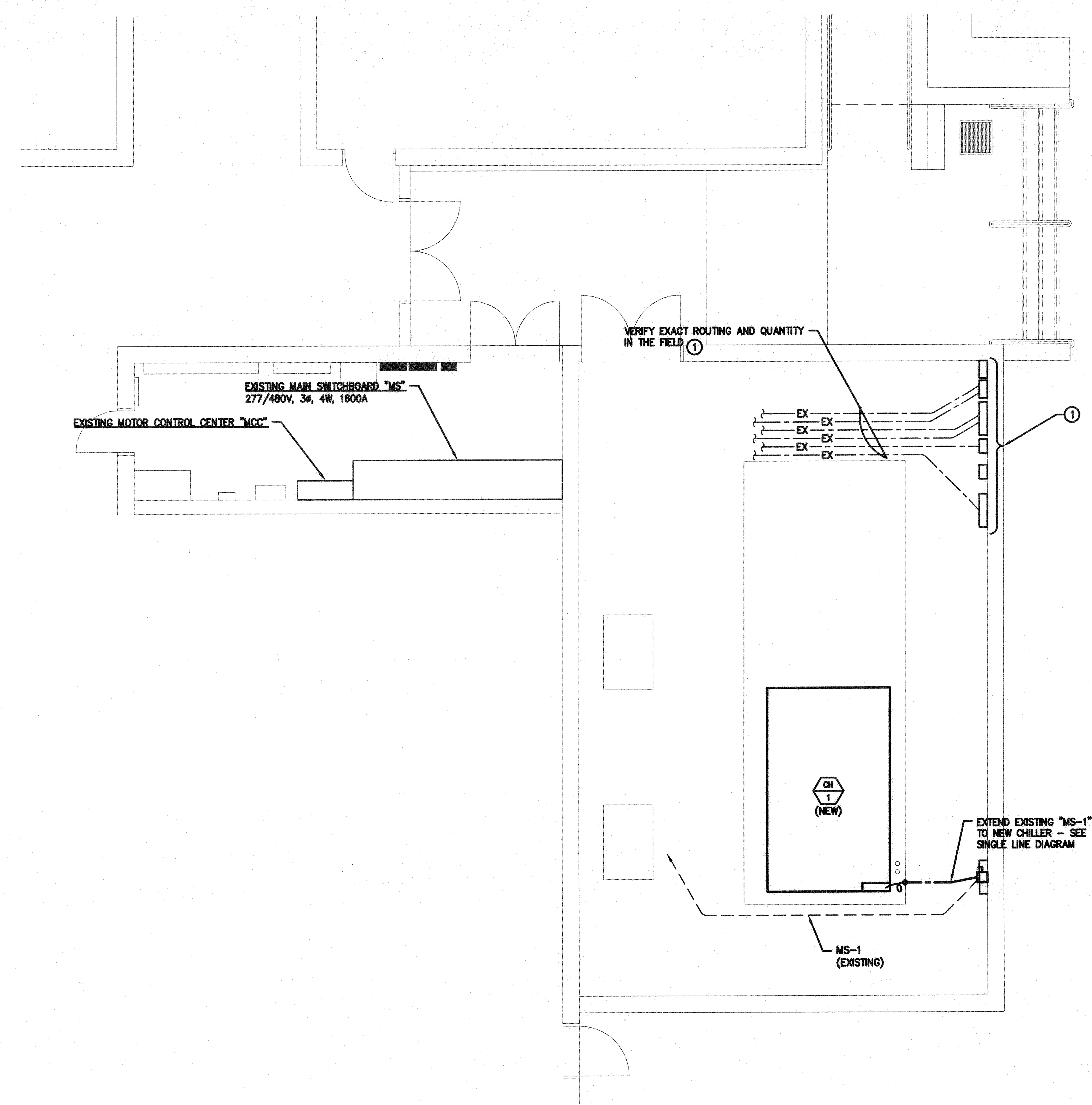
E1.01

KEYNOTES - THIS SHEET ONLY

(1) CONTRACTOR SHALL PROTECT EXISTING ELECTRICAL PULLBOXES AND RELATED CONDUIT, CONDUIT SUPPORTS & ANCHORS IN PLACE DURING CONSTRUCTION. EXPOSED OVERHEAD CONDUITS SHALL BE TEMPORARILY SUPPORTED DURING CONSTRUCTION, AND SHALL BE REATTACHED/RESUPPORTED FROM REINSTALLED STRUCTURE.



PARTIAL FIRST FLOOR PLAN - ELECTRICAL - DEMOLITION
SCALE: 1/4"=1'-0"



PARTIAL FIRST FLOOR PLAN - ELECTRICAL - NEW WORK
SCALE: 1/4"=1'-0"

CONSTRUCTION DOCUMENTS

IDENTIFICATION STAMP
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OFFICE OF REGULATION SERVICES
FILE NO. 19-41
APPL. NO. 03-118364
AC / FLS SS
DATE FEB 07 2018

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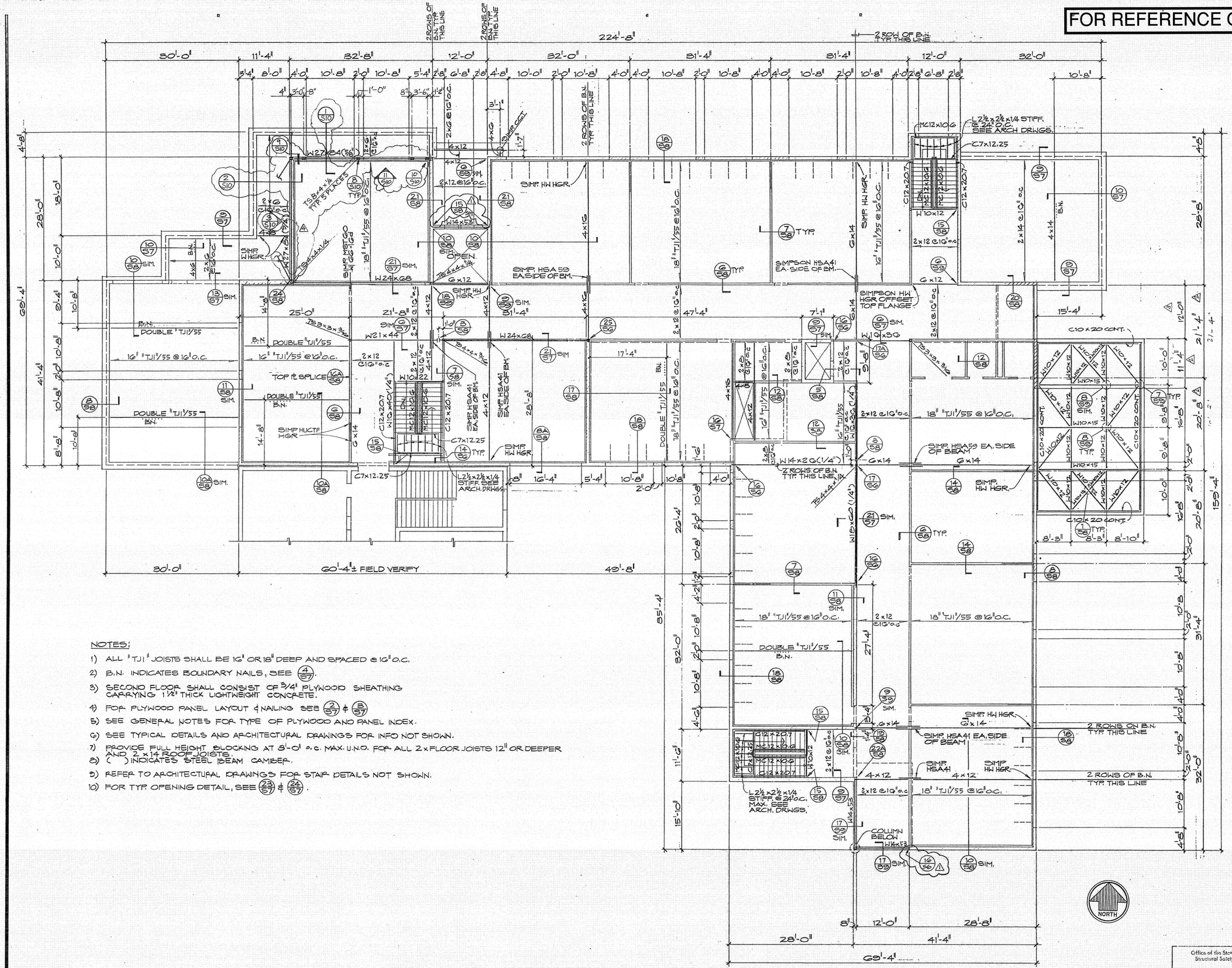
FIRST FLOOR PLANS - ELECTRICAL

E2.01

FOR REFERENCE ONLY



NOTES:

1) ALL "TJI" JOISTS SHALL BE 16" OR 18" DEEP AND SPACED @ 16" O.C.
2) B.N. INDICATES BOUNDARY NAILS, SEE (4/S7).
3) SECOND FLOOR SHALL CONSIST OF 3/4" PLYWOOD SHEATHING CARRYING 1 1/2" THICK LIGHTWEIGHT CONCRETE.
4) FOR PLYWOOD PANEL LAYOUT & NAILING SEE (2/S7) & (5/S7)
5) SEE GENERAL NOTES FOR TYPE OF PLYWOOD AND PANEL INDEX.
6) SEE TYPICAL DETAILS AND ARCHITECTURAL DRAWINGS FOR INFO NOT SHOWN.
7) PROVIDE FULL HEIGHT BLOCKING AT 8'-0" o.c. MAX. U.N.O. FOR ALL 2 x FLOOR JOISTS 12" OR DEEPER AND 2 x 14 ROOF JOISTS.
8) ( ) INDICATES STEEL BEAM CAMBER.
9) REFER TO ARCHITECTURAL DRAWINGS FOR STAIR DETAILS NOT SHOWN.
10) FOR TYP. OPENING DETAIL, SEE (23/S7) & (24/S7).

Office of the State Architect
Structural Safety Section
A51029
PRELIMINARY APPROVAL ONLY
A Change Order is Required
By JH/LA Date 6-12-89

FOR REFERENCE ONLY

Charles Walton Associates AIA Incorporated

Architecture · Planning · Interior Design

320 Arden Avenue · Suite 210
Glendale, California 91203
818 · 240 · 5456

Project
MUIR SCHOOL ADDITION

Office of State Architect
OFFICE OF THE STATE ARCHITECT
STRUCTURAL SAFETY
A51 029 FEB 07 1989
APPROVED
REGIONAL STRUCTURAL ENGINEER

FOR REFERENCE ONLY

State Fire Marshall

IDENTIFICATION STAMP
DIV. OF THE STATE ARCHITECT
APP03 118364
AC. FLS SS
DATE FEB 07 2018

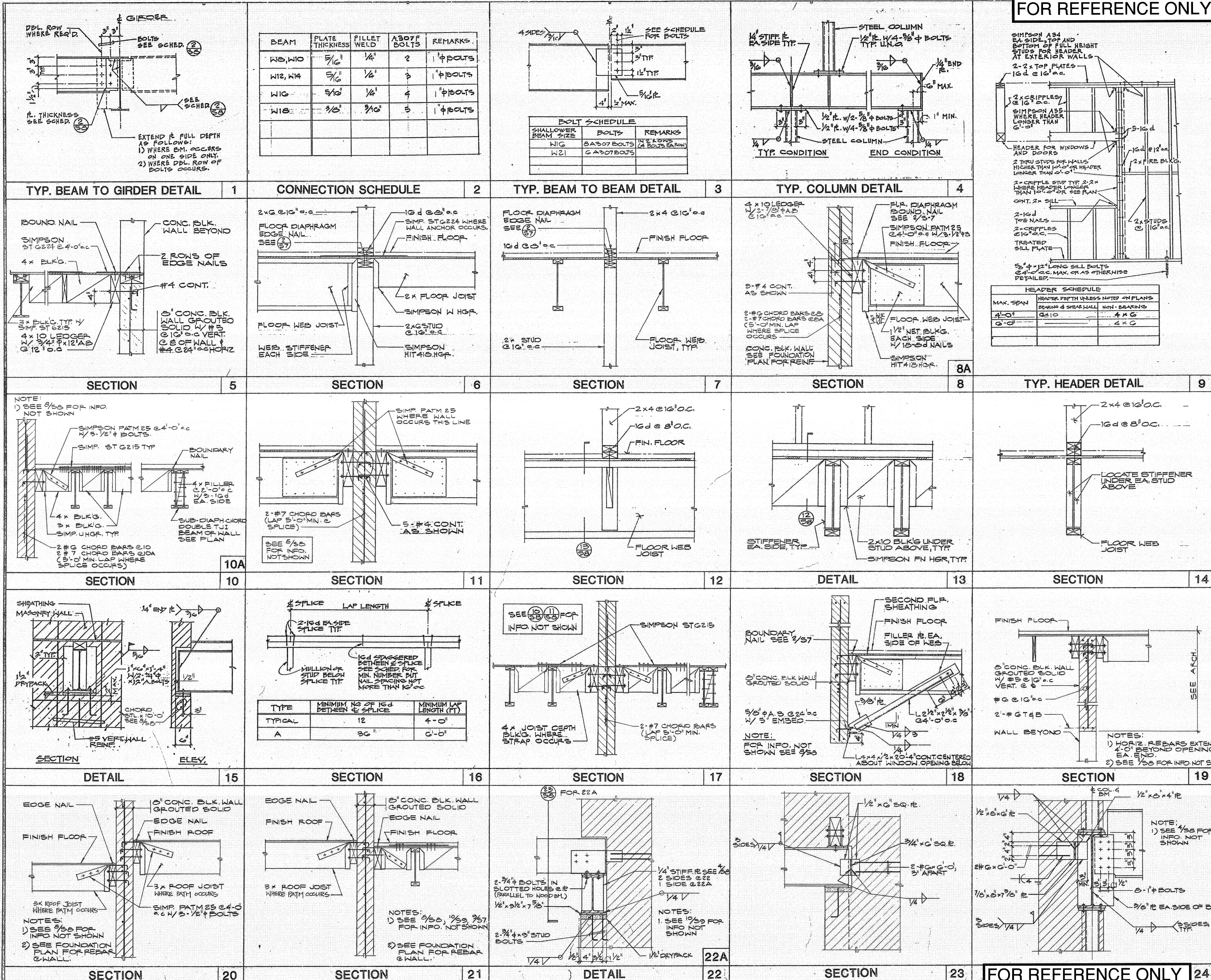
Sheet Title
SECOND FLOOR FRAMING PLAN

Consultant
GROSSMAN & SPEER ASSOCIATES, INC.
STRUCTURAL ENGINEERS
520 HAHN AVENUE, SUITE 200 (818) 507-1020
GLENDALE, CALIFORNIA 91203 FAX (818) 507-1556
#88066

Revisions	Date
1 ADDENDA No. 1	6/12/89
2 REVISED DIMENSIONS	8-9-89
3 REVISED DIMENSION	8-16-89
4 REVISED EXTERIOR WALL	2-14-90
5	
6	
7	

LICENSED ARCHITECT
CHARLES WALTON AIA
C-3367
STATE OF CALIFORNIA

Job No. 88122	Sheet No. S-3 R4
Drawn R.C	
Checked V.K	
Date OCT. 3/88	of Sheets



CONNECTION SCHEDULE

BEAM	PLATE THICKNESS	FILLET WELD	A307F BOLTS	REMARKS
W8, W10	5/16"	1/4"	2	1" ϕ BOLTS
W12, W14	5/16"	1/4"	3	1" ϕ BOLTS
W16	5/16"	1/4"	4	1" ϕ BOLTS
W18	3/8"	5/16"	5	1" ϕ BOLTS

BOLT SCHEDULE

SHALLOWER BEAM SIZE	BOLTS	REMARKS
W16	8 A307 BOLTS	IN 2 ROWS (4 BOLTS EA ROW)
W21	6 A307 BOLTS	

HEADER SCHEDULE

MAX. SPAN	HEADER DEPTH UNLESS NOTED ON PLANS	
	BEARING & SHEAR WALL	NON-BEARING
4'-0"	6x10	4x6
6'-0"	—	4x6

TYPE	MINIMUM NO. OF 16d BETWEEN ℄ SPLICE	MINIMUM LAP LENGTH (FT)
TYPICAL	12	4-0"
A	36	6'-0"

Charles Walton Associates AIA Incorporated

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Project

MUIR SCHOOL ADDITION

Sheet Title

SECTIONS &DETAILS

Consultant

GROSSMAN & SPEER ASSOCIATES, INC.
STRUCTURAL ENGINEERS
529 HARN AVENUE, SUITE 200 GLENDALE, CALIFORNIA 91203 (818) 507-1020 FAX (818) 507-1556

#88066

Revisions	Date
△	
△	
△	
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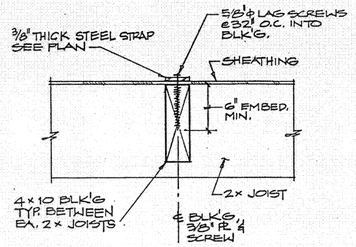
Job No. 88122
Drawn R.C.
Checked V.K.
Date OCT. 3/88

Sheet No. S-8 of Sheets



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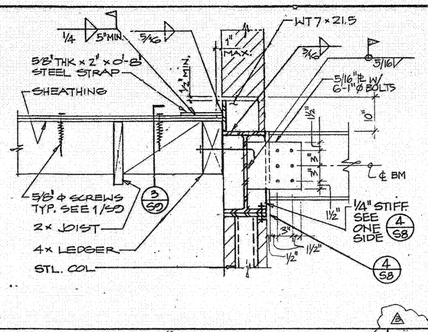

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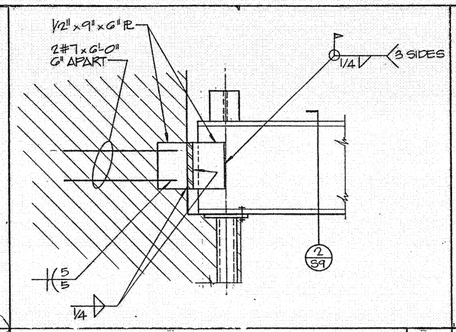

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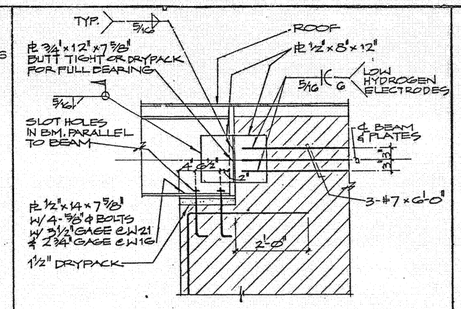

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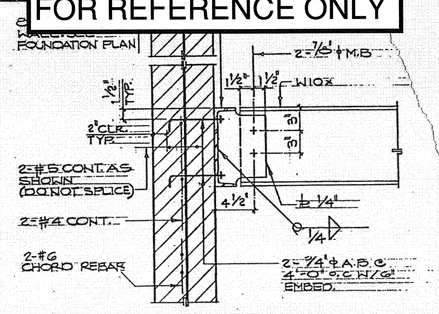

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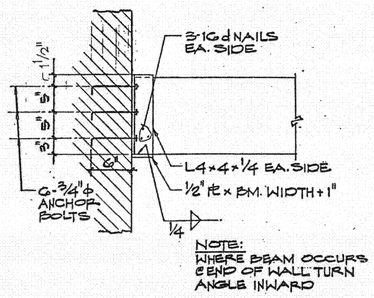

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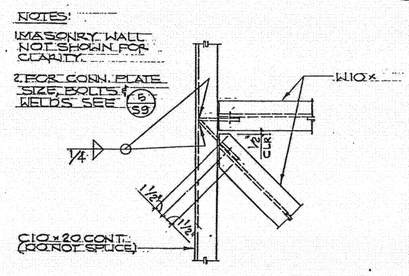

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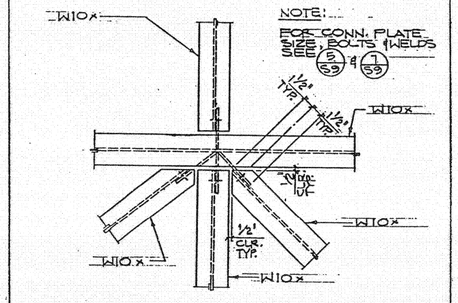

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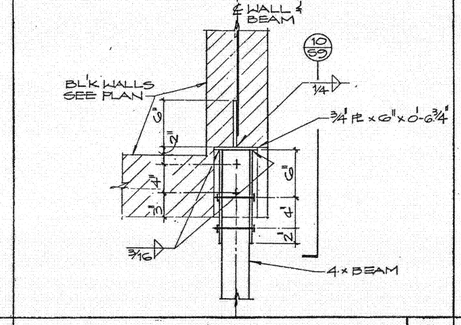

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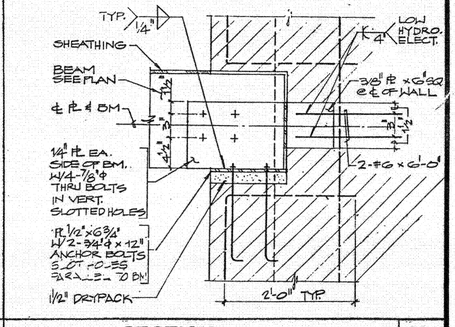

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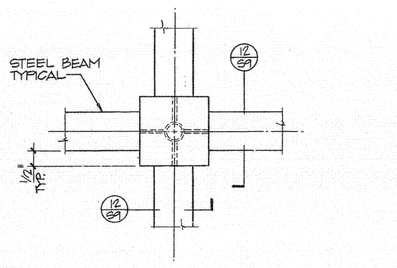
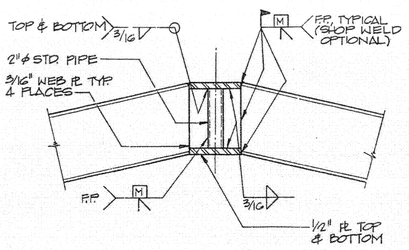
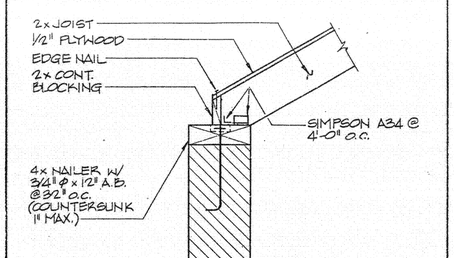


PLAN DETAIL 11



NOTE:
1) 4x NAILER ABOVE STEEL BEAM NOT SHOWN FOR CLARITY.

DETAIL 12



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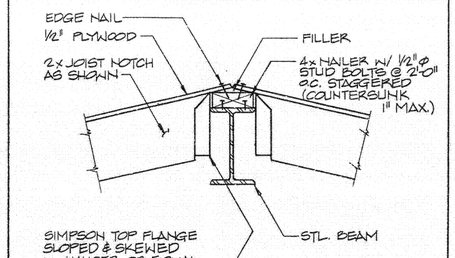

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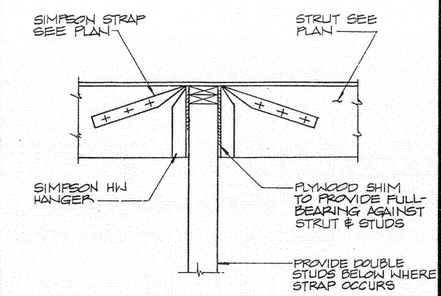

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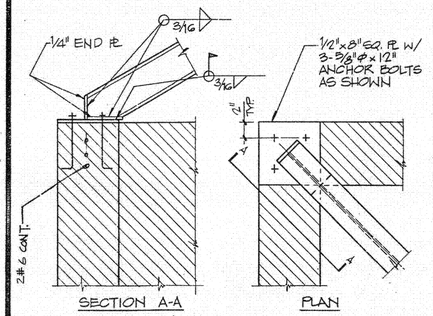

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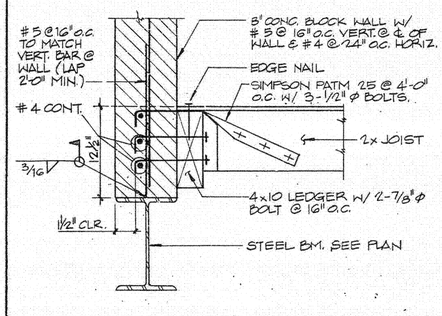

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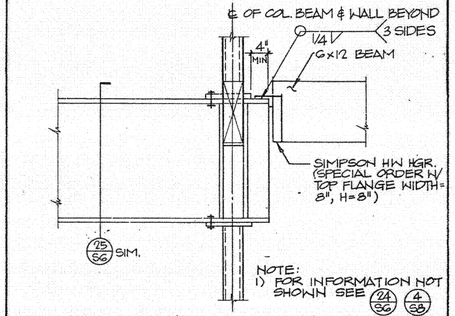
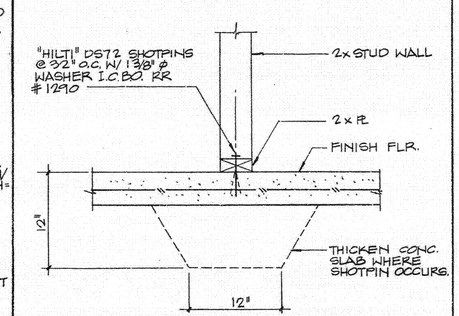
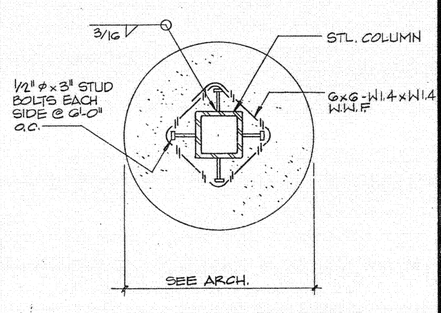


NOTE:
1) FOR INFORMATION NOT SHOWN SEE 24/S9 & 4/S8

DETAIL 18



TYP. PARTITION WALL DETAIL 19



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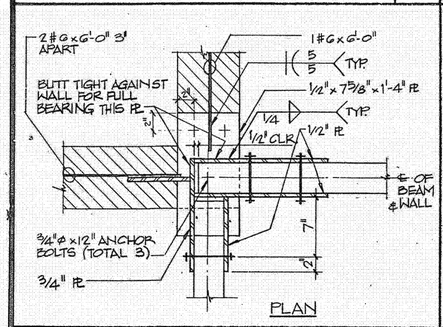

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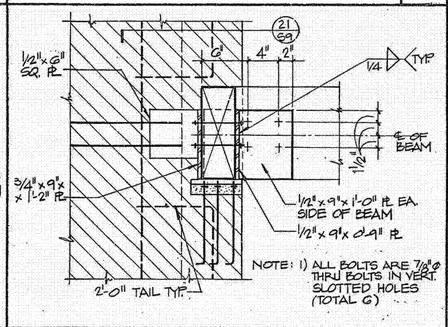
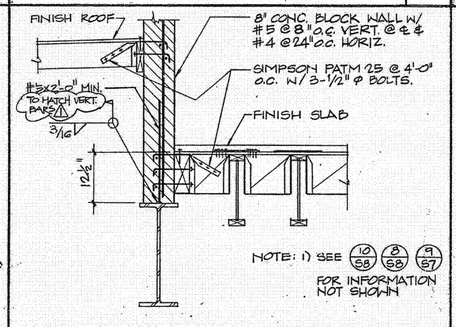


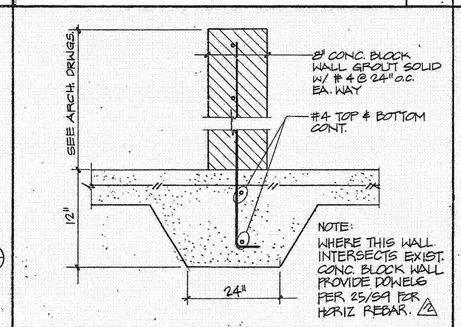
NOTE: 1) ALL BOLTS ARE 7/8" ϕ THRU BOLTS IN VERT. SLOTTED HOLES (TOTAL 6)

DETAIL 22



NOTE: 1) SEE 10/S8 8/S8 9/S7 FOR INFORMATION NOT SHOWN

DETAIL 23



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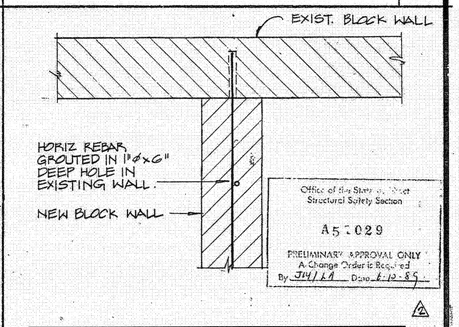

2

SECTION 25

les Walton
ates AIA
porated

re · Planning · Interior Design
20 Arden Avenue · Suite 210
Glendale, California 91203
818 · 240 · 5456

Project
MUIR SCHOOL ADDITION

Office of State Architect

OFFICE OF THE STATE ARCHITECT
STRUCTURAL SAFETY SECTION
A51 029 FEB 07 1989
APPROVED
APPLICATION NO.
PRINCIPAL STRUCTURAL ENGINEER

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DIV. OF THE STATE ARCHITECT
APP03 118364
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Sheet Title
SECTIONS & DETAILS

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Revisions	Date
1 ADDENDA No. 1	6/12/89
2 ADDED DET. #24 & 25	8-16-89
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Sheet No. R 3
S-9
of Sheets

Glendale Unified School District

John Muir Elementary School
Building 2 Prop 39 -HVAC Upgrade

912 S Chevy Chase Rd
Glendale, CA 91205

100% DD
TECHNICAL SPECIFICATIONS

NAC Architecture

Architect's Job No.
A161-17036

July 26, 2017

IDENTIFICATION STAMP
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SECTION 00 01 10 - TABLE OF CONTENTS

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

Not used

DIVISION 31 EARTHWORK

Not Used

DIVISION 32 EXTERIOR IMPROVEMENTS
Not Used

DIVISION 33 UTILITIES

Not Used

APPENDICES

A	Mechanical Equipment Cut Sheets
B	Structural Calculations

END TABLE OF CONTENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Remove designated building equipment and fixtures.

B. Remove designated partitions and components.

C. Identify and cap discontinued utilities.

D. Carefully demolish and remove from the Site those items scheduled to be so demolished and removed. Furnish materials and perform labor required to execute this work as indicated on the drawings, as specified and as necessary to complete the Contract, including, but not limited to, the following items:
   1. Protection of existing items to remain.
   2. Barricades, lights, signs and safety precautions required by the governing code.

E. Removal and disposition of material resulting from this work, except items identified by Owner to be salvaged and delivered to School District. Such items shall include, but not be limited to, existing chalkboards, markerboards, clocks, telephones, speakers, that the Owner may wish to retain.

F. Inventory and removal of existing door hardware and lock cylinders to be delivered to District.

1.02 RELATED WORK

A. Documents affecting work of this Section include, but are not limited to, General Conditions, Supplementary Conditions, and Division 1 of these Specifications.

B. Relocation of utility lines and mechanical structures scheduled to remain active.

C. Site Clearing: Section 31 10 00.

D. Building Demolition: Section 02 41 16.

1.03 GENERAL REQUIREMENTS

A. Codes: Perform Work in accordance with appropriate Codes, and California Fire Code, latest edition, "Article 87 - FIRE SAFETY DURING CONSTRUCTION, ALTERATION, OR DEMOLITION OF A BUILDING."

B. Examine the Site, conditions, and limitations thereon and thereabouts. Bidding shall take into account such conditions and limitations, whether or not the same are specifically mentioned in the Contract Documents, and every bid shall be construed as including whatever sums are needed to complete the Work in every part as shown, described, or reasonably required or implied, and attain the completed conditions contemplated by the Contract. The demolition drawings, including demolition work shown on construction drawings, shall be considered as a guide only. The exact extent of the demolition and reconstruction work shall be determined by a site visit and investigation.

C. Make note of existing asbestos, including asbestos lined pipes, ductwork and equipment, in around, and adjacent to work area. Notify Project Manager if work of the contract may disturb asbestos containing building materials. Removal of asbestos shall be executed by licensed Abatement Contractor. Coordinate Work with trades contracted by Owner to execute the asbestos removal.

D. The use of explosives will not be permitted.

E. Partial Removal: Items scheduled to be removed and of salvageable value to Contractor may be removed from structure as work progresses. Salvaged items must be transported from site as they are removed. Partial removal is subject to the following conditions:
   1. Storage or sale of removed items on site will not be permitted.
   2. This excludes items and materials to be stored for Owner.

F. Unforeseen Conditions: Include in the base bid miscellaneous cutting and patching necessitated as a result of unforeseen conditions. No extra payments based on the pleas of unforeseen conditions will be allowed.

G. Noise control: Carry on work in a manner which will produce the least amount of noise. Instruct workmen in noise control procedures.

H. Removal of abandoned lines, vaults, the erasing of easements, and similar work is a responsibility of the local governmental authority having jurisdiction.

I. Conduct demolition to minimize interference with adjacent building areas. Maintain protected access at all times.

J. Provide and erect temporary barriers and security devices.

1.04 QUALITY ASSURANCE

Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.05 SUBMITTALS

A. Schedule: Submit proposed methods and operations of building demolition to Architect for review prior to start of Work. Include in schedule, coordination for shut-off, capping, and continuation of utility services, as required.

B. Submit five (5) copies of demolition and removal procedures and schedule for Architect's review.

C. Upon completion of the work in this Section, submit Record Drawings recording the extent of active and abandoned underground utilities. The drawings shall be signed and dated by the Contractor and shall be drawn on reproducible sepia. Submit drawings to Inspector of Record and/or transmittal to Architect.

PART 2 - PRODUCTS

2.01 SALVAGE CONTAINER

A. Provide one (1) lockable steel container, 8' x 8' x 20'.

B. Place container where directed by District.

PART 3 - EXECUTION

3.01 PREPARATION

A. Site Security: Erect chain link fence barricades, warning lights, and signs as required by the governing building code, to protect persons from injury, to prevent trespassing, and to prevent theft or damage due to vandalism.

B. Erect weatherproof closures for exterior openings as specified in Section 01 50 00.

C. Notify utility authorities to locate and flag underground lines. Disconnect, remove, and cap designated utility services within demolition areas (related Division 33 Sections).

D. Mark location of disconnect utilities. Identify and indicate capping locations on Project Record Documents.

E. Avoid cutting existing pipe, conduit, or ductwork serving the building but then scheduled to be removed or relocated until provisions have been made to bypass them.

F. Protect landscaping and irrigation systems unless scheduled to be altered (related Division 32 Sections).

G. Ensure safe passage of persons around area of demolition. Conduct operations to prevent injury to adjacent buildings, structures, other facilities, and persons.
   1. Erect temporary covered passageways as required by authorities having jurisdiction.
   2. Provide interior and exterior shoring, bracing, or support as required to prevent movement, settlement, or collapse of building structure to remain.

3.02 SURFACE CONDITIONS

Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.03 DEMOLITION

A. By careful study of the Contract Documents, determine the location and extent of selective demolition to be performed.

B. In company with the Architect, visit the Site and verify the extent and location of selective demolition to be performed.
   1. Carefully identify limits of selective demolition.
   2. Mark interface surfaces as required enabling workmen to identify items to be removed and items to be left in place intact.

C. Prepare and follow an organized plan for demolition and removal of items.
   1. Shut off, cap, and otherwise protect existing public utility lines in accordance with the requirements of the public agency or utility having jurisdiction. Review plans, and confer with the Architect, to determine which lines are to be abandoned and which are to be kept active.
   2. Completely remove items scheduled to be demolished and removed.
   3. Comply with pertinent regulations of governmental agencies having jurisdiction.

D. Demolished material shall be considered to be property of the contractor and shall be completely removed from the job site. Burning of removed materials from demolished structures will not be permitted on Site.

E. Demolish in an orderly and careful manner. Protect existing supporting structural members and finishes which are not to be demolished. Unless shown on the Drawings, no structural elements such as rafters, joists, columns, or studs shall be cut without written permission from the Architect and Division of the State Architect (DSA).

F. Remove and promptly dispose of contaminated, vermin infested, or dangerous materials encountered.

G. Walls:

1. Remove all existing wall covering including but not limited to vinyl wall covering, wallpaper, ceramic tile, wood paneling, and wall carpet where new finishes are scheduled unless noted otherwise.
2. Cut openings where shown, removing sufficient material for proper installation of repairs and new work. Remove any material chipped or otherwise damaged during demolition operations to neat straight line.
3. Remove all existing chalkboards, markerboards and tackboards unless shown to remain.
4. Remove all miscellaneous wood trim and molding where new pinboard is scheduled to facilitate a smooth and continuous surface for the new finish application.
5. Refer to Section 26 05 00, Electrical Requirements.

H. Floors and Base:
1. Remove all existing floor covering and mastic including but not limited to carpet, ceramic tile, vinyl composition tile (VCT), sheet vinyl and wood where new finishes are specified unless otherwise noted. New carpeting may be installed over existing VCT. Damaged VCT to be patched and repaired prior to installation of carpet.
2. Remove sufficient finish flooring to a natural seam including adhesive to present smooth plane, ready for application of new material.

I. Ceilings:
1. Remove existing finished ceilings and wood furring where new ceilings are scheduled.
2. Remove all damaged ceiling tile and prepare substrate for new to match existing adjacent material.

J. Plumbing Fixtures: Remove indicated fixtures, including supplies and traps.

K. Lighting Fixtures: Remove indicated fixtures.

3.04 POLLUTION CONTROLS

A. Use water sprinkling, temporary enclosures and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level.

Comply with governing regulations pertaining to environmental protection.

1. Do not use water when it may create hazardous or objections such as ice, flooding, and pollution.

B. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations, as directed by Architect or governing authorities. Return adjacent areas to condition existing prior to start of Work.

3.05 TRAFFIC

A. Conduct demolition operations and removal of debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

B. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

3.06 UTILITY SERVICES

A. Maintain existing utilities; keep in service, and protect against damage during demolition operations.

B. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.

C. Contractor to set time to meet with Owner's Maintenance technicians for review of on-site utilities serving structures. Disconnecting and sealing indicated utilities before starting demolition operations is part of this work.

D. Locate and protect those irrigation devices which are to remain in use and not be replaced or relocated within the area of demolition or workers' vehicular traffic throughout the entire period of the Project.

E. Buildings that house public address systems and fire alarm, typically in Administration Buildings are to have power maintained at all times. If

power must be interrupted, Contractor must give two (2) weeks prior notice to request written approval and schedule with District for interruption over weekends or when school is not in session.

3.07 REPLACEMENTS

A. In the event of demolition of items not so scheduled to be removed and/or replaced, promptly replace such items to the acceptance of the Architect and at no additional cost to District.

B. Damages: Promptly repair damages caused to adjacent facilities by demolition operations at no additional cost to District.

END OF SECTION

SECTION 07 84 00

FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.

B. Firestopping of all joints and penetrations in fire-resistance rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

C. Joint sealants used in fire-resistive construction.

1.02 SUBMITTALS

A. See Section 01 33 13 - Submittal Procedures.

B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.

C. Product Data: Provide data on product characteristics, performance ratings, and limitations. HPI

D. Report: Submit VOC content documentation for all non-preformed materials. Manufacturer's

E. Installation Instructions: Indicate preparation and installation instructions. Manufacturer's Certificate:

F. Certify that products meet or exceed specified requirements.

1.03 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.

1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.

2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.

3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section and:

1. With minimum 3 years documented experience installing work of this type.

2. Able to show at least 5 satisfactorily completed projects of comparable size and type.

3. Approved by firestopping manufacturer

D. HPI requirements

1. See Section 01 61 13- Volatile Organic Compound Content Requirements.

2. Adhesives: Meet the volatile organic chemicals (VOC) content requirements in the applicable category of South Coast Air Quality Management District (SCAQMD) Rule 1168, Adhesive and Sealant Applications (current version).

3. Adhesives must follow the specifications of the CDPH Standard Practice

1.04 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

B. Provide ventilation in areas where solvent-cured materials are being installed. PART 2

PRODUCTS

2.01 FIRESTOPPING SYSTEMS

A. Firestopping: Any material meeting requirements.

1. Fire Ratings: Use any system listed by UL or tested in accordance with ASTM E814 that has F Rating equal to fire rating of penetrated assembly and T Rating Equal to F Rating and that meets all other specified requirements.

B. Acceptable manufacturers providing code approved systems:

1. 3M Fire Protection Products: www.3m.com/firestop.

2. Bio Fireshiel, www.bioshield.com.

3. Hilti, Inc: www.us.hilti.com.

4. Substitutions: See Section 01 60 00 – Product Requirements.

2.02 FIRESTOPPING; GENERAL

A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Firestopping Materials are either "cast-in-place" (integral with concrete placement) or "post installed." Provide cast-in-place firestop devices prior to concrete placement.

2.03 FIRESTOPPING ASSEMBLIES

A. Firestopping: Any material meeting requirements.

B. Fire Ratings: Use any system listed by UL, FM, or ITS (Warnock Hersey) or tested in accordance with ASTM E 814 that has F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and that meets all other specified requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.

B. Remove incompatible materials that could adversely affect bond.

C. Install backing materials to arrest liquid material leakage.

D. Priming: Prime substrates where recommended in writing by firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.03 INSTALLATION

A. Install materials in manner described in fire test report and in accordance with manufacturer's written instructions, completely closing openings.

B. Do not cover installed firestopping until inspected by authority having jurisdiction. Install

c. labelling required by code.

3.04 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

3.06 SYSTEMS AND APPLICATIONS SCHEDULE

Construction Condition	Manufacturer	Product	Installation Spec.
Metal pipe or conduit through framed walls	3M	FB-CP2SWB+Caulk FB-Moldable Putty	UL System WL1133, WL1146, WL1166, WL1228
	Hilti	FS-ONE High Performance Intumescent Firestop Sealant, CP 620	UL System WL1054, 1058, WL1164
	Tremco	Tremco Fyre Sil Sealant	
Metal pipe or conduit through concrete floors	3M	FB Silicone Sealant 3000 WT, FB-1000 NS, FB-1003SL	UL System CAJ1292
	Hilti	FS-ONE High Performance Intumescent Firestop Sealant, CP 620 Fire Foam, CP 601 Elastomeric Firestop Sealant	UL System CAJ1126, FA 1017
	Tremco	Tremstop Fyre Sil Sealant	
Insulated metal pipe through framed walls	3M	FB CP2SWB+ Caulk, FB FS-195+ Wrap/Strip, FB IC 15 WB+ Caulk	UL System WL5001, WL5002, WL5011, WL5039, WL5040
	Hilti	FS-ONE High Performance Intumescent Firestop Sealant, CP 618 Firestop Putty, CP Firestop Jacket	UL System WL5028, 5029,5047
	Tremco	Tremstop WBM Intumescent Firestop Sealant	

Construction Condition	Manufacturer	Product	Installation Specs
Insulated metal pipe through concrete floors and walls	3M	FB Silicone Sealant 3000 WT, FM CP 25WB+ Caulk, FB FS-195+ Wrap/Strip	UL System CAJ5080, CAJ5119, CAJ5156, CAJ5172, CAJ5172, CAJ5209, CAJ5211, CAJ5017
	Hilti	FS-ONE High Performance Intumescent Firestop Sealant, CP 620 Fire Foam, CP 601 Elastomeric Firestop Sealant	CAJ5098, CAJ5061, FA5015,FA5016
	Tremco	Tremstop WBM Intumescent Firestop Sealant	
Plastic pipe through framed walls	3M	FB CP25W+ Caulk, FB FS-195+ Wrap/ Strip, FB IC15WB+ Caulk, FB Moldable Putty+, FireDam 150+ Caulk	Ul System WL2002, WL2003, WL2073, WL2087, WL2097, WL2148, WL2154, WL2162, WL2264
	Hilti	FS-ONE High Performance Intumescent Firestop Sealant, CP 642 Firestop Jacket, CP 643 Firestop Jacket, CP 645 Wrap Strips	UL System WL2075, WL 2078, WL 2128

Construction Conditions	Manufacturer	Product	Installation Specs
Plastic pipe through concrete floors	3M	FM Silicone Sealant 3000WT, FB CP25WB+ Caulk, FB FS-195+ Wrap/Strip, FB IC 15WB+ Caulk	UL System CAJ2005, CAJ2161, CAJ 2214, CAJ2228, CAJ2242, CAJ2378
	Hilti	FS-ONE High Performance Intumescent Firestop Sealant, CP 642 Firestop Jacket, CP 643 Firestop Jacket, CP 645 Wrap Strips	UL System CAJ2098, CAJ 2109, CAJ2141, CAJ2167, CBJ2021, FA2053, FA2025, CBJ2021
Cable tray through concrete floors and walls	3M	FB Moldable Putty +, FB Pillows, FB Self-Locking Pillows	CAJ4056
	Hilti	CP 637 Trowelable Firestop Compound, FS 657 Fire Block, CP 620 Fire Foam	UL System CAJ4034, CAJ4036, WJ401
Cable tray through framed walls	3M	FB CP25WB+ Caulk, FB CS-195+ Composite Sheet, FB E-FIS Flexible Seal, FB Moldable Putty+, FB Pillows	WL4018, WL4044, WL4052, WL4067
	Hilti	CP 637 Trowelable Firestop Compound, FS 657 Fire Block, CP 620 Fire Foam	UL System WL 4011, WL 4019
Alternately, terminate cable tray prior to fire wall			Design Modification
Telephone, fiber optic, and other small misc. conductors through framed walls	3M	FB CP25WB+ Caulk, FB FS-195+ Wrap/ Strip, FB IC 15WB+ Caulk, FB Moldable Putty+, FireDam 150+ Caulk	UL System WL3001, WL3030, WL3074, WL3149, WL3195, WL3337
	Hilti	FS-ONE, CP 620, CP 606, CP601S	UL System CAJ 3005, WL 3065, WL 3111, WL 3112

Construction Condition	Manufacturer	Products	Installation Specs
Control joints and wall/floor joints, at framed and concrete. Install UL rated assembly that meets ASTM C920, Class A movement.	3M	FireDam Spray 200, FB Silicone Sealant 1000 NS, FB 2000 N/S Silicone Sealant, FB CP25VVB+ Caulk, FB IC 15VVB+ Caulk, FireDam 150+ Caulk	UL System HWD0170, HWD0265, BWS0007,BVVS0008
	Hilti	FS-ONE High Performance Intumescent Firestop Sealant, CP 601S Elastomeric Firestop Sealant, CP 606 Flexible Firestop Sealant, CP 604 Self-leveling Firestop Sealant	Manufacturer's Specifications
Curtain wall/ construction gap - Install UL rated assembly that meets ASTM C920, Class A movement	3M	FB 2000 N/S Silicon Sealant, FB Silicone Sealant 1000 NS, FireDam Spray 200, FireDam 150+ Caulk,	3MU/PH 60-03, 3MU/PH 60-04, 3MU/PV6003
	Hilti	CP 672 Firestop Joint Spray, CP 601 Elastomeric Firestop sealant, CP 601S Elastomeric Firestop Sealant, CP 606 Flexible Firestop Sealant, CP 604 Self-leveling firestop Sealant	At concrete walls: CAJ 7046, CAJ 7051, at framed walls: VVL 7017, VVL 7040, VVL 7042
	Tremco	Tremstop Fyre Sil Sealant	
Non insulated HVAC ducts	3M	FB Duct Wrap 615-DVV, FB Silicone Sealant 1000 NS	3MU/PH 60-03, 3MU/PH 60-04, 3MU/PV6003
	Hilti	CP 601S	At concrete walls: CAJ 7046, CAJ 7051; at framed walls: VVL 7017, VVL 7040, VVL 7042
Seismic and other large building joints	Install UL rated assembly that meets ASTM C920, Class A movement		

END OF SECTION

SECTION 07 90 05

JOINT SEALERS

PART1 GENERAL

1.01 SECTION INCLUDES

A. Sealants and joint backing.

B. Precompressed foam sealers. C.

Related work:

1. Section 07 84 00 - Firestopping: Firestopping sealants.

1.02 DEFINITIONS

A. Based on ASTM C 920 Substrates:

1. M type substrates: Concrete, concrete masonry units, brick, mortar, natural stone. The term "masonry" means brick, stone, and concrete masonry work.

2. G type substrates: Glass and transparent plastic glazing sheets.

3. A type substrates: Metals, porcelain, glazed tile, and smooth plastics.

4. O type substrates: Wood, unglazed tile; substrates not included under other categories

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with other sections referencing this section.

B. Ensure compatibility of sealant with adjacent materials.

1.04 SUBMITTALS

A. See Section 01 33 13- Submittal Procedures.

B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

C. Samples: Submit two samples, 6 inch long illustrating sealant colors for selection.

D. Submit certification form seal manufacturer that sealant is compatible with adjacent materials. HPI

E. Report: Submit VOC content documentation for all non-preformed sealants and primers. Manufacturer's

F. Installation Instructions: Indicate special procedures.

1.05 QUALITY ASSURANCE

A. Maintain one copy of each referenced document covering installation requirements on site.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

C. Applicator Qualifications: Company specializing in performing the work of this section with minimum three years experience.

D. HPI requirements

1. See Section 01 61 13- Volatile Organic Compound Content Requirements.

2. Adhesives: Meet the volatile organic chemicals (VOC) content requirements in the

applicable category of South Coast Air Quality Management District (SCAQMD) Rule 1168, Adhesive and Sealant Applications (current version).

3. Adhesives must follow the specifications of the CDPH Standard Practice

1.06 MOCK-UP

A. Provide mock-up of sealant joints in conjunction with window under provisions of Section 01 40 00.

B. Construct mock-up with specified sealant types and with other components noted, see Section 09 24 00 Portland Cement Plastering. C.

Locate where directed.

D. Mock-up may remain as part of the Work.

1.07 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.08 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Correct defective work within a five year period after Date of Substantial Completion.

C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 SEALANTS

A. Sealants and Primers - General: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

B. Type SJ-1 -General Purpose Exterior Sealant: Polyurethane; ASTM C920, Grade NS, Class 25, Uses M, G, and A; single component.

1. Acceptable Manufacturer:

a. Product: Sikaflex -1a manufactured by Sika.

b. Product: Dynatrol II manufactured by Pecora Corp. c.

Product: Dymonic FC manufactured by Tremco.

d. Substitutions: See Section 01 60 00- Product Requirements.

2. Applications: Use for:

a. Control, expansion, and soft joints in masonry. b.

Joints between concrete and other materials.

c. Joints between metal frames and other materials.

d. Other exterior joints for which no other sealant is indicated.

C. Type SJ-2 - Exterior Expansion Joint Sealer: Multi-component self-leveling polyurethane sealant, ASTM C 920, Type M, Grade P, Class 25, Use T.

1. Size as indicated on drawings, if not detailed, then per manufacturer's recommendation to provide weathertight seal when installed.
2. Provide product recommended by manufacturer for traffic-bearing use.
3. Acceptable manufacturer's:
   a. Product: Sonolastic SL 2 manufactured by Sonneborn BASF. b.

      Product: DynaTrolll SG manufactured by Pecora Corp.

   c. Product: THC-900 manufactured by Tremco.
   d. Substitutions: See Section 01 60 00 - Product Requirements.
4. Applications: Use for:
   a. Exterior horizontal joints in concrete flatwork and extruded curbs.

D. Type SJ-3- Silicone Sealant: ASTM C 920, TypeS, Grade NS, Class 100/50, Uses NT, A, G; single component, solvent curing, non-sagging, non-staining, non-bleeding.

1. Color: Match adjacent finished surfaces.
2. Acceptable Manufacturers:
   a. Product: 790 manufactured by Dow Corning Corp. b.

      Product: SikaSii-C 990 manufactured by Sika Corp. c.

      Product: Spectrum 1 manufactured by Tremco.

   d. Substitutions: See Section 01 60 00 - Product Requirements.
3. Movement Capability: Plus 100 percent, minus 50 percent.
4. Service Temperature Range: -65 to 180 degrees F.
5. Shore A Hardness Range: 15 to 35.
6. Applications: Use for:
   a. Glazing at aluminum frames.

E. Type SJ-4 - Exterior Metal Lap Joint Sealant: One-part non-sag silyl terminated polyether sealant: ASTM C-920, TypeS. Grade NS, Class 25, Use NT, T, M, G, A, O.

1. Acceptable Manufacturer
   a. Product: DynaTrol I-XL manufactured by Pecora Corp.. b.

      Product: Sikaflex 721 UV manufactured by Sika.

   c. Product: Sonolastic 150 with VLM Technology manufactured by Sonneborn BASF. d.

      Substitutions: See Section 01 60 00- Product Requirements.
2. Applications: Use for:
   a. Concealed sealant bead in sheet metal work.

F. Type SJ-5- General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, Type OP, Grade NF single component, paintable.

1. Color: To be selected by Architect from manufacturer's standard range.

2. Acceptable manufacturers;

a. Product: Tremcoflex 834 manufactured by Tremco.

b. Product: AC-20+SIIicone manufactured by Pecora Corp. c.

Product: Sonolac manufactured by Sonneborn BASF.

d. Substitutions: See Section 01 60 00- Product Requirements.

3. Applications: Use for:

a. Interior wall and ceiling control joints.

b. Joints between door and window frames and wall surfaces.

c. Other interior joints for which no other type of sealant is indicated.

G. Type SJ-6- Bathtub/Tile Sealant: White silicone; ASTM C920, Uses I, MandA; single component, mildew resistant.

1. Acceptable Manufacturers:

a. Product: Tremsil 200 with fungicide manufactured by Tremco. b.

Product: Pecora 989 manufactured by Pecora Corp.

c. Product: #786 manufactured by Dow Corning Corp.

d. Substitutions: See Section 01 60 00- Product Requirements.

2. Applications: Use for:

a. Joints between plumbing fixtures and floor and wall surfaces.

b. Joints between countertops with fawcets and wall surfaces and backsplash.

H. Type SJ-7- Acoustical Sealant: Non-skinning, sound dampering; single component, solvent release curing, non-skinning.

1. Acceptable Manufacturers:

a. Product: Acoustical Sealant manufactured by Tremco.

b. Product: Sheetrock Acoustical Sealant manufactured by United States Gypsum Co. c.

Product: AcoustiSeal (Professional Series) Acoustical Sealant manufactured by Acoustical Surfaces, Inc, Chaska, MN.

d. Substitutions: See Section 01 60 00- Product Requirements.

2. Applications: Use for concealed locations only:

a. Sealant bead between top stud runner and structure and between bottom stud track and floor.

2.02 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width; Backer Rod manufactured by Backer Rod

Manufacturing, Inc., Denver, CO.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant. Clean

B. and prime joints in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193. Protect

D. elements surrounding the work of this section from damage or disfigurement.

3.03 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform installation in accordance with ASTM C1193.

C. Perform acoustical sealant application work in accordance with ASTM C919. Install

D. bond breaker where joint backing is not used.

E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Tool joints concave.

H. Precompressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.

I. Compression Gaskets: Avoid joints except at ends, corners, and intersections; seal all joints with adhesive; install with face 1/8 to 1/4 inch below adjoining surface.

3.04 CLEANING

A. Clean adjacent soiled surfaces.

3.05 PROTECTION

A. Protect sealants until cured.

3.06 SCHEDULE

A. Control and Expansion Joints in Paving: Type SJ-2.

B. Joints between concrete caps and between caps and adjacent ork: Type SJ-1.

C. Control, Expansion, and Soft Joints in Masonry, and Between Masonry and Adjacent Work: Type SJ-1.

D. Lap Joints in Exterior Sheet Metal Work: Type SJ-4.

E. Joints Between Exterior Metal Frames and Adjacent Work (except masonry): Type SJ-1. F.

Under Exterior Door Thresholds: Type SJ-4.

G. Interior Joints for Which No Other Sealant is Indicated: Type SJ-5; None; N/A. H.

Control and Expansion Joints in Interior Concrete Slabs and Floors: Type SJ-2.

I. Joints Between Plumbing Fixtures and Walls and Floors, and Between Countertops and Walls: Type SJ-6.

J. In Sound Rated Walls, Between Metal Stud Track/Runner and Adjacent Construction: Type SJ-:7.

END OF SECTION

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. HVAC demolition.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Concrete bases.
10. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.

3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Mechanical sleeve seals.
2. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Plastic. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

C. One-Piece, Floor-Plate Type: Cast-iron floor plate.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    c. Insulated Piping: One-piece, stamped-steel type with spring clips.
    d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast-brass type with polished chrome-plated finish.
    g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
    i. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

    a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
    d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.

e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 23 05 19 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Filled-system thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.
7. Sight flow indicators.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ashcroft Inc.
    b. Marsh Bellofram.
    c. Miljoco Corporation.
    d. Palmer Wahl Instrumentation Group.
    e. REOTEMP Instrument Corporation.
    f. Trerice, H. O. Co.
    g. Weiss Instruments, Inc.

2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Connector Type(s): Union joint, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.

2.2 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.

11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Ernst Flow Industries.
   d. Flo Fab Inc.
   e. Marsh Bellofram.
   f. Miljoco Corporation.
   g. Noshok.
   h. Palmer Wahl Instrumentation Group.
   i. REOTEMP Instrument Corporation.
   j. Tel-Tru Manufacturing Company.
   k. Trerice, H. O. Co.
   l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   m. Weiss Instruments, Inc.
   n. WIKA Instrument Corporation - USA.
   o. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Sealed; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Brass.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS ½, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS ½ pipe threads.

C. Valves: Brass ball, with NPS 1/4 or NPS ½, ASME B1.20.1 pipe threads.

2.6 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
8. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM self-sealing rubber.

2.7 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
8. Weiss Instruments, Inc.

B. Furnish one test-plug kit(s) containing two thermometers, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

2.8 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Archon Industries, Inc.
2. Dwyer Instruments, Inc.
3. Emerson Process Management; Brooks Instrument.
4. Ernst Co., John C., Inc.
5. Ernst Flow Industries.
6. KOBOLD Instruments, Inc. - USA; KOBOLD Messring GmbH.
7. OPW Engineered Systems; a Dover company.
8. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 psig.

E. Minimum Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install remote-mounted pressure gages on panel.

J. Install valve and snubber in piping for each pressure gage for fluids (except steam).

K. Install valve and syphon fitting in piping for each pressure gage for steam.

L. Install test plugs in piping tees.

M. Install flow indicators in piping systems in accessible positions for easy viewing.

N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

O. Install flowmeter elements in accessible positions in piping systems.

P. Install permanent indicators on walls or brackets in accessible and readable positions.

Q. Install connection fittings in accessible locations for attachment to portable indicators.

R. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.
6. Inlet and outlet of each thermal-storage tank.
7. Outside-, return-, supply-, and mixed-air ducts.

S. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlets and outlets of each chiller shall be the following:

1. Direct-mounted, metal-case, vapor-actuated type.

B. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:

1. Direct-mounted, metal-case, vapor-actuated type.

C. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be the following:

1. Direct-mounted, metal-case, vapor-actuated type.

D. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be the following:

1. Sealed, direct-mounted, metal case.

B. Pressure gages at suction and discharge of each pump shall be the following:

1. Sealed, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 200 psi.

END OF SECTION

SECTION 23 05 23 – GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. Iron, single-flange butterfly valves.
   3. Iron swing check valves.
   4. Bronze swing check valves.
   5. Chainwheels.

B. Related Sections:
   1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. NIBCO INC
   b. Hammond Valve.
   c. Kitz Valve Corporation
   d. Milwaukee Valve Company.

2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hammond Valve.
   b. Kitz Corporation.
   c. Milwaukee Valve Company.
   d. NIBCO INC.

2. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Aluminum bronze.

2.4 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. NIBCO INC
   b. Hammond Valve.
   c. Kitz Valve Corporation
   d. Milwaukee Valve Company.

2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 300 psig.
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.5 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Kitz Corporation.
      b. Milwaukee Valve Company.
      c. NIBCO INC.

   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. NPS 14 to NPS 24, CWP Rating: 150 psig.
      d. Body Design: Clear or full waterway.
      e. Body Material: ASTM A 126, gray iron with bolted bonnet.
      f. Ends: Flanged.
      g. Trim: Bronze.
      h. Gasket: Asbestos free.

2.6 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Babbitt Steam Specialty Co.
   2. Roto Hammer Industries.
   3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   2. Attachment: For connection to ball and butterfly valve stems.
   3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
   4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for ball or butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball or butterfly valves.
   2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   3. Throttling Service: ball, or butterfly valves.
   4. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
      b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 HEATING-HOT WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with bronze trim.
   3. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
   3. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
   4. Iron Swing Check Valves: Class 125, metal seats.

END OF SECTION

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.
    c. Flex-Strut Inc.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut Corporation; Tyco International, Ltd.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.
    c. Flex-Strut Inc.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut Corporation; Tyco International, Ltd.

2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, **zinc-coated** steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, **NPS 2-1/2** and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

O. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's unique equipment number.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, manufacturer, model number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 incheshigh.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

F. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in other sections.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Chilled-Water Piping:

a. Background Color: Blue.
b. Letter Color: White.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. All Valve-Tags: 1-1/2 inches minimum, round.

2. Valve-Tag Color:

a. All Valve-Tags: Natural.

3. Letter Color:
a. All Valve-Tags: Black.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Hydronic Piping Systems:

a. Variable-flow hydronic systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. TAB: Testing, adjusting, and balancing.

C. TAB Specialist: An entity engaged to perform TAB Work.

1.4 ACTION SUBMITTALS

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC as a TAB technician.

B. TAB Conference: Meet with the District on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by the District

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, and SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.5 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

    a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from the Districtand comply with requirements in Section 232123 "Hydronic Pumps."

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

    a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.6 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.7 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

3.9 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check the condition of coils.
5. Check the operation of the drain pan and condensate-drain trap.
6. Check bearings and other lubricated parts for proper lubrication.
7. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.10 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.11 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to

facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.

d. Face and bypass damper settings at coils.
e. Fan drive settings including settings and percentage of maximum pitch diameter.
f. Inlet vane settings for variable-air-volume systems.
g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.

h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.

j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.

i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

J. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.13 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

   a. Measure airflow of at least 10 percent of air outlets.
   b. Measure water flow of at least 5 percent of terminals.
   c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   d. Verify that balancing devices are marked with final balance position.
   e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by the District
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the District
3. the District shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 16 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:

1. Chillers.
2. Chilled-water pumps.
3. Expansion/compression tanks.
4. Air separators.

B. Related Sections:

1. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail removable insulation at equipment connections.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.
6. Detail field application for each equipment type.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Sheet and K-FLEX LS.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CertaPro Commercial Board.
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ramco Insulation, Inc.; Super-Stik.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Foster Brand, Specialty Construction Brands, Inc., a business of H .B. Fuller Company; 30-80/30-90.
    b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    b. Eagle Bridges - Marathon Industries; 550.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.
    e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    c. Vimasco Corporation; 713 and 714.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Joint Sealants:

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.

c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; CHP-1.
2) GEMCO; Cupped Head Weld Pin.
3) Midwest Fasteners, Inc.; Cupped Head.

4) Nelson Stud Welding; CHP.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

A. Wire: 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. C & F Wire.

2.11 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040 inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.6 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with the following:

1. Flexible Elastomeric: 1 inch thick.

D. Chilled-water pump insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. Ft nominal density.

E. Chilled-water expansion/compression tank insulation shall be one of the following:

1. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft nominal density.
2. Mineral-Fiber Pipe and Tank: 1 inch thick.

F. Chilled-water air-separator insulation shall be one of the following:

1. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft nominal density.
2. Mineral-Fiber Pipe and Tank: 1 inch thick.

3.9 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. None.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. None.

3.10 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Painted Aluminum, Smooth: 0.024 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Painted Aluminum, Smooth: 0.024 inch thick.

END OF SECTION

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Chilled-water piping, indoors and outdoors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ramco Insulation, Inc.; Super-Stik.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.

b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   d. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 428 AWF ASJ.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    c. Compac Corporation; 104 and 105.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 491 AWF FSK.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    c. Compac Corporation; 110 and 111.
    d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ITW Insulation Systems; Gerrard Strapping and Seals.
    b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. C & F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [2 inches] [4 inches] o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Chilled Water:

1. Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water:

1. All Pipe Sizes: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.

3.13 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Section 232113.13 "Underground Hydronic Piping".

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

   1. None.

D. Piping, Exposed:

   1. None.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

   1. None.

D. Piping, Exposed:

   1. Painted Aluminum, Corrugated: 0.024 inch thick.

3.16 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

SECTION 23 09 13 – ENERGY MANAGEMENT CONTROL SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK: Provide all work for the complete installation of automatic temperature controls.

A. Work in this Section: Principal items include:
   1. Electronic and electric controls, includes sensors, switches, relays, control panels for instruments.
   2. Electric motors for air dampers, valves, etc.
   3. Local control panels.
   4. Adjustment and validation of control system. Instruction of Owner's representative on maintenance and operation of control equipment.
   5. Electric diagrams showing interlocks between equipment furnished under the other sections and control furnished herein.
   6. Direct digital control for systems.
   7. Wiring and Conduit: low voltage wire for the control system under Division 23, all low voltage control conduit, all required power wiring, high voltage wire and high voltage conduit under Division 26.
   8. Contractor shall install the latest version of DDC Control Software.

1.03 SYSTEM

A. The Temperature Control System shall be installed as a installed project and shall consist of all sensors, actuators, direct digital controllers, supervisory controller, electrical low voltage (24 VAC) and line voltage control wiring for a complete and operating installation as specified herein. The system shall be a standard product with the manufacturer who will guarantee ongoing parts availability and factory trained field support for five (5) years after system acceptance.

1.04 RELATED SECTIONS

A. Refer to Division 09 for patching and painting required for the control system installation. Not work of this section.

B. Automatic dampers in ductwork, casings, etc. furnished and installed by the Mechanical Division under control people's supervision. The dampers shall be correctly installed so that they operate freely and close tightly. Provide and install blank off plates when the control application requires dampers smaller than duct size.

C. Refer to Division-26 sections for the following work; not work of this section:
   1. Power supply wiring for power source to power connection on controls and/or unit control panels, including starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

1.05 QUALITY ASSURANCE

A. Codes and Standards:
   1. General: The publications listed below form a part of this specification to the extent applicable:

ASHRAE	Handbook of Fundamentals, Latest Edition.
EIA	Electrical Characteristics of Balanced Voltage Digital Interface Circuits;
RS-485.	
NEMA	Enclosures for Electrical Equipment (1000 volts maximum); 250-1979
NFPA 70	National Electrical Code; 1981
NFPA 90A	Air Conditioning and Ventilation Systems; 1981

1.06 SUBMITTALS

A. Submit installation drawings, sequences of operation and catalog cut sheets for each device of the proposed system prior to installation for engineer's approval. The drawings shall include the location and intercommunication of all stand-alone and subordinate control panels; the schematic diagrams, of the controlled equipment with sensors and actuators shown interconnected to the system controllers; and logic diagrams that depict the sequence of operation.

B. After completion of the installation and commissioning of the system including final adjustments, a full set of as-built documentation shall be turned over to the Owner. The as-builts shall include one (1) set of reproducible drawings and two (2) copies of the database on flexible or removable hard disk for each stand-alone controller and the supervisory computer.
   1. As-built documentation shall include diagrammatic layouts of the automatic control systems specified herein. Layouts shall show all control equipment, and the function of each item shall be indicated for the different seasons, Layouts shall be located in plastic protective folder and placed in the control panels.
   2. All Drawings shall be accompanied with a complete description of sequence of operation. Each control element mentioned in the sequence description shall be identified with the same mark as shown- on the control diagram.

C. Submittal of Materials:
   1. Material submittals shall be manufacturers prepared catalog cuts indicating type, size and technical details.
   2. Reference catalog cuts to the applicable specification article (e.g. 2.02A).
   3. Catalog cuts shall be submitted in complete groups of manufacturer's material.
   4. Partial submittals of groups or systems are not acceptable.
   5. Verify that the submittal has been reviewed in detail and is in fact the Contractor's choice of materials.

D. Upon receipt of contract and prior to the delivery of parts, submit eight copies of the following drawings:
   1. Submit eight copies of schematic drawings showing the respective locations of components, as applicable and interconnecting wiring between all devices. Also all field terminal and sensing devices. Also all field terminal and sensing devices shall be listed by function and point number and shall display interconnecting wiring and terminals of controlled systems and devices.

E. Submit eight copies of schematic drawings showing electric connection details for actuators, transducers, and other electric components. All connections shall be labeled to coordinate with the description of operation, including descriptions to indicate action of components, normal positions, spring ranges, etc.

1.07 MANUFACTURERS

A. Carrier I-VU Controls. No substitutions will be accepted.

B. Controls installation will be by Russell Sigler, Inc. Controls Group Certified Installer, Brea, California.

1.08 WARRANTY

A. Provide all labor, material and equipment necessary to maintain beneficial performance of the entire Building Automation System for a period of one (1) year after acceptance of the system, or parts thereof, by an authorized representative of the Owner. Any defects in workmanship or material during the warranty period shall be promptly corrected by the Contractor at no charge to the Owner. All work shall be accomplished during normal working hours, Monday through Friday excluding legal holidays. Precaution shall be taken to minimize disruption of facility operations.

B. A prepaid Warranty Service Agreement shall be turned over to the Owner at the time of the acceptance test as a prerequisite of system acceptance. The contract shall include the terms and conditions stated herein.

C. Service work shall be performed by service personnel in the direct employ of the control contractors. The service technicians shall be factory trained and certified by the manufacturer to be competent in all aspects of the installed system. The technician

shall have a working knowledge of calibration techniques, preventive maintenance, troubleshooting, software diagnostics and microprocessor repair.

D. Provide preventive maintenance at one (1) month intervals such that one twelfth of the system is tested and re-commissioned if necessary at each monthly inspection. An Owner's representative shall certify that the monthly test has been conducted and the control system is functioning properly. A log of tasks performed at each test shall be maintained by the controls contractor and signed by the Owner as evidence of satisfactory completion of the Warranty Service Agreement. The log shall be retained on site and available for review by authorized personnel.

E. System modifications shall be incorporated into the as-built documentation and/or operators and maintenance manuals when operating parameters, control point settings or control strategies are changed. System modifications made by the user of the controls contractor shall have both parties' approvals in order to maintain the Warranty Service Agreement. All database changes shall be saved on disk for backup to the system.

F. Software upgrade program shall be implemented on the anniversary or anniversaries of the warranty period. The upgrade shall provide all enhancements offered by the manufacturer for programs in the accepted systems.

G. System enhancements beyond the scope of the project shall be field upgradable with pull out/plug-in ease. Provided at reasonable value added cost these upgrades may be purchased at the Owner's option.

PART 2 - PRODUCTS

2.01 COMMUNICATION

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2004, BACnet.

B. Install new wiring and network devices as required to provide a complete and workable control network.

C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
   1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller in-

formation such as data and status shall be viewable and editable from each internetwork controller.

2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.

2.02 FIELD INSTALLED SENSORS

A. Temperature Sensors
   1. Type. Temperature sensors shall be nominal 10K ohm thermistor type.
   2. Duct Sensors. Duct sensors shall be single point.
   3. Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.

B. Status Indication
   1. Status indication for fans shall be provided by a current sensing sensor. The sensor shall be installed at the motor starter or motor to provide load indication. The unit shall consist of a current transformer, a solid state current sensing circuit (with adjustable set point) and a solid state switch. A red light emitting diode (LED) shall indicate the on off status of the unit. The switch shall provide a N.O. contact for wiring back to the Field Installed Controller.

2.03 CONTROLLER SOFTWARE

A. Building and energy management application software shall reside and operate in system controllers. Applications shall be configurable through the operator workstation, web browser interface, or engineering workstation.

B. Memory and System Time. All controllers shall have a Non-Volatile Memory providing indefinite storage of application and configuration data. The system must have an ability to maintain time, and automatically correct for daylight savings time and leap year adjustments. In the event of power failure or user generated power cycle, all system components must automatically updated with current time and date from a network Time Sync device. The controller shall also have the capability of changing occupancy mode by reading a set of discrete, dry contacts controlled by an external time clock.

C. Stand alone capability. All controllers shall be capable of providing all control functions of the HVAC system without the use of a computer. The controllers shall include the inherent capability to access the system control selections as well as to mon-

itor system performance by means of a communicating network with a PC and EMS software program.

D. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms.

E. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

F. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

G. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of preconfigured minimum on-time and off-time settings, customized for the specific requirements of the application.

H. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

2.04 CONTROLLERS

A. General. The control system shall be available as a complete package with the required input sensors and devices readily available. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), and Sensors (SEN) as required to achieve performance specified in Paragraph 2.4.

B. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. unless otherwise specified.

C. BACnet.
   1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
   2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
   3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in

ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.

4. BACnet Communication.
   a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
   b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
   c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
   d. Each ASC shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.

D. Communication.
   1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
   2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
   3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
   4. Stand-Alone Operation. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

E. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
   1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
   2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

F. Keypad. Where specified provide a local keypad and display for each BC and ASC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and ASC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

G. Serviceability.

1. Controllers shall have diagnostic LEDs for power, communication, and processor.
2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
3. All controllers in the system shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

H. Memory.
1. Controller memory shall support operating system, database, and programming requirements.
2. Each controller in the system shall use nonvolatile memory providing indefinite storage of BIOS, application programming, and all configuration data in the event of power loss.

I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

J. Rooftop Unit Controller (RTC). Defined as Application Specific Controllers (ASC), shall control all associated HVAC Constant Volume rooftop equipment functions, this operation shall be provided when operating within a zoning system application, as specified for an air source control, in Paragraph 2.4 or in a stand-alone mode. The resident algorithms shall use error reduction logic as designated in ASHRAE standard 90.1 to provide temperature control and energy usage.
1. Capacity control shall be based on the use of a conventional thermostat, or programmable thermostat, or alternatively, a constant volume unit may utilize its own internal time clock and setpoints (cooling and heating) coupled with a room (wired or network communicating) sensor for capacity control. The controls shall provide separate occupied and unoccupied cooling and heating setpoints – except if a conventional thermostat is used.
2. RTC shall feature and maintain a 365-day Real-Time Clock/Calendar with holiday functions.
3. RTC shall be capable of stand-alone or networked operation.
4. In the stand alone mode, each RTC shall establish occupancy scheduling based on its own local occupancy schedule, the closure of a contact connected to an external time clock or EMS system, or by a timed override request (1 to 24 hours) through its space temperature sensor override button.
5. When networked, RTC occupancy may be established by user interface or occupancy signal from other controller located in network.
6. RTC shall utilize fan control, 2 stages of cooling, and up to 3 stages of heating to maintain zone temperature at setpoint.
7. RTC shall provide analog output signal for economizer control.

K. Integration to Lighting Panel(s)

1. Control Contractor Provide a Carrier I-V Link for Intergration BACnet/IP.
2. Lighting panel(s) provided and installed by Division 26 for monitoring and controlling of lighting and operation oriented graphic user interface.
3. Lighting panels provided will support BACnet/IP. Any gateways or additional cards required will be provided and installed by Division 26.
4. Refer to Electrical and Mechanical drawings for points will be integrated to the Carrier I-Vu web server BACnet/IP.

2.05 SYSTEM INTERFACE (District Wide Web Server Existing)

A. Description. The control system shall be as shown and consist of a high-speed, peer-to-peer network of DDC controllers and a stand alone web server operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface. Operators with sufficient access level shall have an ability to make changes to all system and equipment graphics in the web server in addition to having full DDC system access to make configuration changes to the control system. Any tools required for making graphic changes shall be provided with web server.

B. Operator Interface. Operators shall be able to access all necessary operational information in the DDC system via client computer utilizing IE web browser. Client computer and IE web browsing software shall not be furnished under this section.
1. Web server shall connect via the LAN and be able to simultaneously serve up controller information to multiple operators connected via LAN with IE web browsers. Each client web browser connected to server shall be able to access all system information.
2. Web server shall be compatible with Wireless Access Protocol (WAP) enabled cellular telephone or personal digital assistant (PDA). The PDA/WAP interface may be text-based and shall provide a summary of the most important data.
3. With the use of a remote SMTP email server the operators interface web server shall be able to notify personnel of an alarm or record information about an alarm in the DDC system.

C. Web Server Hardware. Furnish one compact web server with Ethernet port for LAN or direct operator client computer access. The web server shall be capable of communicating to the peer to peer DDC controller network. Any required installation or commissioning software shall be pre-installed on the web server. Installation or commissioning of the web server shall be done through a client computer with a standard web browser.

D. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135-2004, BACnet Annex J.

E. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
   1. Log In and Log Out. System shall require user name and password to log in to operator interface.
   2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
   3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as set points, PID gains, on and off controls, and sensor calibration.
   4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
   5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms. Remote users shall be able to receive alarms via emails or cell phone text messages.
   6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
   7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
   8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
   9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

F. System Software.
   1. Operating System and required software. Web server operator interface shall be a self contained web server without the need for any type of maintenance. Any required operating system or software shall be factory loaded and maintenance free.
   2. System Graphics. Operator interface shall be graphical and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each

floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

G. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard Windows compatible PCs with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration. Each web server shall store internally store a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
3. System Configuration. Operators shall be able to configure the system.
4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.
5. Security. System shall require a user name and password to view, edit, add, or delete data.
    a. Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.
    b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
    c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.

6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Points List. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server from each workstation or web browser interface.
11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Points List. Trends shall be BACnet trend objects.
12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics.
13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
14. Standard Reports. Furnish the following standard system reports:
    a. Reports shall be filtered based upon the selected equipment
    b. Alarm Reports
        1) Alarm Summary - Current alarms
        2) Alarm Sources – List of equipment and associated alarm conditions
        3) Alarm Actions – Configured alarm actions such as e-mail and alarm pop-up
    c. Schedule Reports
        1) Effective Schedules – Displays effective schedules for each equipment
        2) Schedule Instances – Displays all schedules entered
    d. Security Reports – Maintains audit of all actions taken through user interface
    e. Commissioning Reports – Provide equipment checkout status and notes

f. Equipment Reports – Provide reports showing trended points and available network points

15. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
16. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
17. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.

PART 3 - EXECUTION

3.01 GENERAL

A. All system components and appurtenances shall be installed in accordance with the manufacturer's instructions and requirements. All necessary interconnections, services and adjustments required for a complete and operable system, shall be provided by this contractor who shall be a Carrier certified installer of the systems herein.

302 INSTALLATION

A. GENERAL
   1. Electric Wiring: This contractor is responsible for all electrical installation and wiring for a fully operational Building Control System as shown on the drawings and shall include all items not shown on the electrical plans or required as per the electrical specifications. Perform all electrical installation in accordance with local and national electrical codes. Plenum wire may be used in ceilings where anchored support is provided every 10 feet.
   2. Provide shields as required by equipment manufacturer.

3.03 PERMITS AND FEES

A. This contractor shall secure and pay for all necessary permits, licenses and inspections as required by federal, state or local law. This includes providing required notices, plans, licenses, and fees, obtaining any necessary approvals from authorities having jurisdiction, and delivering any certificates of inspection as may be required. No work is to proceed until all proper certificates and licenses are obtained and posted.

3.04 CLEAN-UP

A. This contractor shall clean up regularly in order to maintain clean site conditions. In general, clean-up programs shall be scheduled by contractor at least once per week; however, the contractor shall clean up more often if required to meet OSHA standards.

B. This contractor is responsible for coordinating the work with other trades so as to eliminate unnecessary cutting and patching.

3.05 EQUIPMENT INSTALLATION

A. Space Thermostat and Sensor Locations: In general, locate thermostats and sensors for room control immediately inside door, next to light switch at approximately 48 inches from floor. Coordinate thermostat locations with General Contractor and approval by Engineer.

B. Local Control Panels: Mount all local control panels as indicated on the control drawings.

3.06 CUTTING AND PATCHING

A. This contractor is responsible for coordinating the work with other trades so as to eliminate unnecessary cutting and patching.

3.07 EQUIPMENT INSTALLATION

A. Space Thermostat and Sensor Locations: In general, locate thermostats and sensors for room control immediately inside door, above light switch at approximately 60 inches from floor. Coordinate thermostat locations with General Contractor and approval by Engineer.

B. Local Control Panels: Mount all local control panels as indicated on the control drawings.

3.08 OWNER TRAINING

A. Provide classroom training for 2 owner technicians, classes to include i-VU-Standard and Plus, i-VU-Open VVT, and i-VU-Advanced Graphics, total of 32 hours per student. Owner's representatives shall be provided a booklet showing the system layout, components, and operation and maintenance data.

B. Training to include.
   1. Explanation of drawings and diagrams.
   2. Walk-thru of jobsite to locate control components
   3. Overview of operation and maintenance features.
      a. System front end operation (where applicable)

C. Manufacturer will operate a free 40 hour a week customer support hotline for additional user support services that are required within the first 12 months after installation is accepted by Owner's Representative.

END OF SECTION

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Chilled-water piping.
2. Makeup-water piping.
3. Air-vent piping.
4. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Chemical treatment.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Chilled-Water Piping: 100 psig at 150 deg F.
2. Air-Vent Piping: 200 deg F.
3. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. A.Y. McDonald Mfg. Co.
   b. Capitol Manufacturing Company.
   c. Hart Industries International, Inc.
   d. Matco-Norca.
   e. Watts Regulator Co.
   f. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.

2. Description:

   a. Standard: ASSE 1079.
   b. Pressure Rating: 150 psig.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Matco-Norca.
   d. Watts Regulator Co.
   e. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.

2. Description:

   a. Standard: ASSE 1079.
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 150 psig.
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Description:

   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig.

c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elster Perfection.
b. Grinnell Mechanical Products.
c. Matco-Norca.
d. Precision Plumbing Products, Inc.
e. Victaulic Company.

2. Description:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple, complying with ASTM F 1545.
c. Pressure Rating: 300 psig at 225 deg F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

2.6 BYPASS CHEMICAL FEEDER

A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Chilled-water piping, aboveground, NPS 2 and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Makeup-water piping installed aboveground shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

E. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

F. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling.

B. Install bypass chemical feeders in each hydronic system where indicated.

1. Install in upright position with top of funnel not more than 48 inches above the floor.
2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.

C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 30 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 23 21 16 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes special-duty valves and specialties for the following:

1. Chilled-water piping.
2. Makeup-water piping.
3. Air-vent piping.
4. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Chilled-Water Piping: 100 psig at 150 deg F.
2. Makeup-Water Piping: 80 psig at 150 deg F.
3. Air-Vent Piping: 200 deg F.
4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump.
   c. Flow Design Inc.
   d. Griswold Controls.
   e. Nexus Valve, Inc.
   f. Taco.
   g. Tour & Andersson.

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250 deg F (121 deg C).

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump.
    c. Flow Design Inc.
    d. Griswold Controls.
    e. Nexus Valve, Inc.
    f. Taco.
    g. Tour & Andersson.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig (860 kPa).
11. Maximum Operating Temperature: 250 deg F (121 deg C).

E. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett Domestic Pump.
    d. Watts Regulator Co.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Watts Regulator Co.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flow Design Inc.
b. Griswold Controls.
c. Nexus Valve, Inc.

2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig (1207 kPa).
9. Maximum Operating Temperature: 200 deg F (93 deg C).

2.3 AIR-CONTROL DEVICES

A. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Taco, Inc.

2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.

4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2 (DN 15).
6. Discharge Connection: NPS 1/4 (DN 8).
7. CWP Rating: 150 psig (1035 kPa).
8. Maximum Operating Temperature: 240 deg F (116 deg C).

B. Bladder-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Taco, Inc.

2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. [Diaphragm] [Bladder]: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

C. Tangential-Type Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Taco, Inc.

2. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.
3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
4. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
5. Blowdown Connection: Threaded.
6. Size: Match system flow capacity.

2.4 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.

3. Strainer Screen: Stainless-steel, 60-mesh strainer.
4. CWP Rating: 125 psig (860 kPa).

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (860 kPa).

C. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig (5170 kPa).

D. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping."Section 15124 "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install check valves at each pump discharge and elsewhere as required to control flow direction.

C. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

D. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

B. Install piping from boiler air separator to expansion tank with a 2 percent upward slope toward tank.

C. Install tangential air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.

D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION

SECTION 23 64 23 - SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.3 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

B. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

C. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 506/110 and referenced to ARI standard rating conditions.

D. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

E. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 506/110 and intended for operating conditions other than the ARI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Scroll water chillers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Refrigerant capacity of water chiller.
5. Oil capacity of water chiller.
6. Fluid capacity of evaporator.
7. Fluid capacity of condenser.
8. Characteristics of safety relief valves.
9. Minimum entering condenser-air temperature
10. Performance at varying capacity with constant design entering condenser-air temperature. Repeat performance at varying capacity for different entering condenser-air temperatures from design to minimum in 10 deg F increments.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

C. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Certificates: For water chillers, accessories, and components from manufacturers.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.

E. Startup service reports.

F. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 590 certification program.

B. ARI Rating: Rate water chiller performance according to requirements in ARI 506/110, "Water Chilling Packages Using the Vapor Compression Cycle."

C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.

D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

F. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

B. Package water chiller for export shipping.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified period.

1. Compressor Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED AIR-COOLED WATER CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation.
2. Trane.
3. Daikin.

B. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

C. Fabricate base, frame, and attachment to water chiller components strong enough to resist movement during a seismic event when water chiller base is anchored to field support structure.

D. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
3. Casing: Galvanized steel.
4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
5. Sound-reduction package consisting of the following:

a. Acoustic enclosure around compressors.
b. Reduced-speed fans with acoustic treatment.
c. Designed to reduce sound level without affecting performance.

6. Security Package: Provide security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.

E. Compressors:

1. Description: Positive-displacement direct drive with hermetically sealed casing.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.

3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
4. Capacity Control: On-off compressor cycling, plus hot-gas bypass.
5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
6. Vibration Isolation: Mount individual compressors on vibration isolators.

F. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

G. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

H. Refrigeration:

1. Refrigerant: R-410a. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

I. Evaporator:

1. Shell and Tube:

a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
c. Shell Material: Carbon steel.
d. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.
f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

J. Air-Cooled Condenser:

1. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig.

a. Construct coils of copper tubes mechanically bonded to aluminum fins.
b. Coat coils with a baked epoxy corrosion-resistant coating after fabrication.

c. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.

K. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
6. Provide each motor with overcurrent protection.
7. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
8. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
9. Provide power factor correction capacitors to correct power factor to 0.90 at full load.
10. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

    a. Power unit-mounted controls where indicated.
    b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.

11. Control Relays: Auxiliary and adjustable time-delay relays.
12. Indicate the following for water chiller electrical power supply:

    a. Current, phase to phase, for all three phases.
    b. Voltage, phase to phase and phase to neutral for all three phases.
    c. Three-phase real power (kilowatts).
    d. Three-phase reactive power (kilovolt amperes reactive).
    e. Power factor.
    f. Running log of total power versus time (kilowatt hours).
    g. Fault log, with time and date of each.

L. Controls:

1. Stand-alone, microprocessor based.
2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:

    a. Date and time.

b. Operating or alarm status.
c. Operating hours.
d. Outside-air temperature if required for chilled-water reset.
e. Temperature and pressure of operating set points.
f. Entering and leaving temperatures of chilled water.
g. Refrigerant pressures in evaporator and condenser.
h. Saturation temperature in evaporator and condenser.
i. No cooling load condition.
j. Elapsed time meter (compressor run status).
k. Pump status.
l. Antirecycling timer status.
m. Percent of maximum motor amperage.
n. Current-limit set point.
o. Number of compressor starts.

4. Control Functions:

a. Manual or automatic startup and shutdown time schedule.
b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on space temperature.
c. Current limit and demand limit.
d. External water chiller emergency stop.
e. Antirecycling timer.
f. Automatic lead-lag switching.

5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

a. Low evaporator pressure or high condenser pressure.
b. Low chilled-water temperature.
c. Refrigerant high pressure.
d. High or low oil pressure.
e. High oil temperature.
f. Loss of chilled-water flow.
g. Control device failure.

6. Building Automation System Interface: Factory-installed hardware and software to enable building automation system to monitor, control, and display water chiller status and alarms.

a. Industry-accepted open-protocol communication interface with building automation system shall enable building automation system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building automation system.

M. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
2. Thickness: 3/4 inch.

3. Factory-applied insulation over cold surfaces of water chiller components.

   a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.

4. Apply protective coating to exposed surfaces of insulation.

N. Accessories:

1. Factory-furnished, chilled-water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.

2.2 SOURCE QUALITY CONTROL

A. Perform functional test of water chillers before shipping.

B. Factory performance test water chillers, before shipping, according to ARI 506/110, "Water Chilling Packages Using the Vapor Compression Cycle."

1. Allow Owner access to place where water chillers are being tested. Notify Architect 14 days in advance of testing.

C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

D. For water chillers located outdoors, rate sound power level according to ARI 370 procedure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER CHILLER INSTALLATION

A. Install water chillers on support structure indicated.

B. Equipment Mounting:

1. Install water chillers on cast-in-place concrete equipment bases.

2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

E. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve. Make connections to water chiller with a mechanical coupling.

D. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gages are installed.
4. Operate water chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
9. Verify and record performance of chilled-water flow and low-temperature interlocks.
10. Verify and record performance of water chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Prepare a written startup report that records results of tests and inspections.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.

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.

1.04 AIR CONDITIONING, HEATING, PLUMBING EQUIPMENT WIRING

A. 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.

1.06 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.)
      f. NECA/NEIS-230: Recommended Practice for Installing Motors
      j. NECA/NEIS-400: Recommended Practice for Installing and Maintaining Switchboards
      k. NECA/NEIS-402: Recommended Practice for Installing and Maintaining Motor Control Centers
      n. NECA/NEIS-407: Recommended Practice for Installing Panelboards

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, 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.

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.

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

A. 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
   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

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.

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 weatherproof gaskets for all exterior boxes.

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

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

2. Double Pole Switch
   Hubbell

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

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.

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.

2.13 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.

3.06 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.
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. Fo· 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. Fo· 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 — 45 & 90 Degree Angle Connectors
      1) Thomas & Betts-3110 Series (with locknut) — 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

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.

2.03 CONDUIT SUPPORTS

A. General
1. Conduit Supports, hangers and fasteners for metal conduit shall be steel, hot dip zinc galvanized.

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
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.

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.

2.06 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).

PART 3 - EXECUTION

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

   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.

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.

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.

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.

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.

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.

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.

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.

3.07 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 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 submittal data for all new fuses to be installed in existing switches.

B. Provide nameplate engraving schedule for all new / replacement nameplates.

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.

PART 2 - PRODUCTS

2.01 BUSSING

A. All Bussing is existing – to remain.

2.02 CIRCUIT BREAKERS

A. All circuit breakers and fusible switches are existing to remain.

B. Install new fuses in existing fusible switches as indicated on the drawings and as specified herein.

2.03 SWITCH AND FUSE FEEDER PROTECTIVE DEVICES

A. Fusible Switches: Fusible switches are existing to remain. Install new fuses in existing fusible switches as indicated on the drawings and as specified herein.
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.

2.05 MAIN SWITCHBOARDS

A. The Main Switchboard is existing to remain.

B. The Main Switchboard shall be modified and upgraded as indicated on the Drawings. The upgrades and modifications shall include (but shall not be limited to) the addition/removal of circuit breakers, fusible switches, new fuses in existing fusible switches, new nameplates for revised devices, new cover plates, etc.

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 ALTERATIONS AND ADDITIONS TO EXISTING SWITCHBOARDS

A. Furnish and install new devices as indicated in existing Main Switchboard.

B. After installation of new components, the boards shall be carefully cleaned.

C. Provide new engraved nameplates for all new and revised devices installed in existing switchboards. Nameplates shall be as specified and shall match existing nameplates for existing devices.

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.

END OF SECTION

SECTION 26 24 16
BRANCH CIRCUIT PANELBOARDS

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 submittal data for all new circuit breakers to be installed in existing panelboards.

PART 2 - PRODUCTS

2.01 PANELBOARDS

A. All panelboards are existing – to remain.

B. The existing panelboards shall be modified and upgraded as indicated on the Drawings. The upgrades and modifications shall include (but shall not be limited to) the addition/removal of circuit breakers, new cover plates, etc. – as noted.

C. Furnish and install new circuit breakers in spaces indicated, complete with all required mounting hardware, cover plates, etc.

D. The Contractor shall prepare a ***new*** neatly typewritten schedule with number or name of room or area, or load served by each ***new and existing*** panelboard circuit. Do not 'mark-up' the existing schedule. Prepare a complete new schedule indicating all new and existing branch circuits as described above.

2.03 PANEL CIRCUIT BREAKERS, CIRCUIT PROTECTION DEVICES

A. New circuit breakers installed in existing panelboards shall match the existing characteristics of the existing circuit breakers (in the same panelboard) as noted on the drawings and as required.

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.
   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.

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.
   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.

PART 3 - EXECUTION

3.01 MOUNTING

A. All panelboards are existing as indicated on the drawings.

3.03 UPGRADE OF EXISTING PANELBOARDS

B. As indicated on the Drawings, certain existing panelboards shall be modified and upgraded with new circuit breakers. These modifications include the addition and/or removal of individual circuit breakers for new and revised loads.

C. Furnish and install updated schedule for upgraded and revised panelboards as specified in this section.

END OF SECTION

SECTION 26 24 19
MOTOR CONTROL EQUIPMENT

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.

PART 2 - PRODUCTS

2.01 GENERAL

A. Division 240000 HVAC/Plumbing
   Refer to Division 260000 Mechanical and Plumbing Contract Documents and shop drawings for additional electrical work and material requirements.
   1. Provide all control devices including timeswitches, relays, auxiliary contacts, voltage transformers, and interlocks.
   2. Provide all raceways, conduit wire, circuits, outlets, and interconnections of starters as required for HVAC and Plumbing systems.

B. Special Considerations
   1. Mount all auxiliary relays and timeswitches in an isolated compartment inside motor control equipment unless otherwise indicated.
   2. Whether or not shown on mechanical and plumbing Contract Documents and/or control schedules, where motors are controlled by external devices (i.e., thermostats, relays, float or pressure switches, etc.) or interlocked with other motors, provide each magnetic motor starter with a "Hand-Off-Auto" selector switch in starter cover. Other magnetic motor starters provide a "Start-Stop" push-button station in starter cover.
   3. Motor starters, motor controllers and circuit feeder tap devices for motor circuits shall be rated and labeled for control of all electric motor design types A, B, C, D, and E pursuant to the requirements of the NEC

2.02 MANUAL MOTOR STARTERS

A. Provide flush or surface mounting manual motor starters with number of poles and size of thermal overload heaters as required for the motor being controlled (equipped with overload heaters, one (1) for each motor lead). Back boxes shall be supplied with all flush mounting starters, whether they are toggle type requiring only a 4-inch square outlet box or the larger type requiring a special box. Provide cover designed to accept the particular unit.

B. Unless otherwise noted on the drawings, all manual starters for single phase motors, smaller than 1 h.p. shall be the compact toggle type. Manual starters for all single phase motors, 1 to 5 h.p. and all three phase motors up to 5 h.p. shall be the heavy-duty type.

C. Where manual motor starter is shown with pilot light, the pilot light shall be installed in a separate outlet box adjacent to the starter outlet with engraved nameplate to indicate function of pilot light. Pilot lights shall be push-to-test style.

PART 3 - EXECUTION

3.01 MOTOR CONTROL CENTER AND INDIVIDUAL COMBINATION MOTOR STARTERS

A. Install motor control equipment in accordance with manufacturer's written instructions and

applicable portions of NEMA "Standards of Installations" for switchboards and motor control centers and individual motor starters.

3.03 SETTINGS AND ADJUSTMENTS

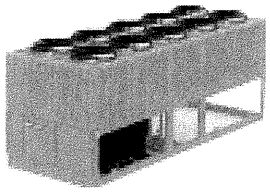
A. Program and set control function sequences, time delays, and protective device settings for correct system operation.

B. Test all timing, control sequences and motor rotation direction for proper operation. Correct deficiencies and retest until proper operation is confirmed.

END OF SECTION

Technical Data Sheet for CH-1

Job Information	Technical Data Sheet
Job Name	Muir ES Chiller Replacement
Date	7/6/2017
Submitted By	Brandon Musich
Software Version	07.60
Unit Tag	CH-1



Unit Overview

Model Number	Capacity ton	IPLV.IP* EER Btu/W.h	Voltage	Unit Starter Type	ASHRAE 90.1	LEED EA Credit 4
AGZ140E	134.3	15.70	460 / 60.0 / 3	Across the Line	'07, '10, '13/'16	Pass

** IPLV reflects AHRI standard rating conditions and does not change with user defined conditions.*

Unit

Unit Type	Platform	Unit Revision
Air-Cooled Scroll Compressor Chiller	Packaged + Pump Package	00

Head Pressure	Tubing
Fantrol Only (32°F Min)	Replaceable Filter Dryer with Discharge & Liquid Valves, no HGBP

Unit Controls	Display
Electronic Expansion Valve	On Controller only

Refrigerant Type	Refrigerant Weight
R410A	152 lb (per unit)

Pump Controls

Dual Evaporator Pumps - Dual Control Output

Approval

ETL/cETL, AHRI & ASHRAE 90.1

Evaporator

Water Volume:	15.0 gal
Connection Hand:	Universal Connection - Facing out back
Connection Size:	6.0 in
Insulation:	Single Layer Insulation to Suction Compressor Tee

Entering Fluid Temperature	Leaving Fluid Temperature	Fluid Type	Fluid Flow	Fluid Flow Min / Max	Pressure Drop	Fouling Factor
55.00 °F	44.00°F	Water	291.8 gpm	128.9/ 537.2 gpm	8.20 ft H_2O	0.000100 °F.ft².h/Btu

Condenser

Coil Fins:	MicroChannel (Electro Fin Coating)
Guards:	Condenser Coil Louvers & Base Frame Wire Grilles

Design Ambient Air Temperature	Altitude	Fan Diameter	Nominal Fan Motor Horsepower	Minimum Design Ambient Temperature
100.0 °F	0.000 ft	30.0 in	2.0 hp	32.0 °F

Technical Data Sheet for CH-1

Unit Performance

Design

Capacity	Input Power	Efficiency (EER)	IPLV.IP* (EER)
134.3 ton	164.2 kW	9.800 Btu/W.h	15.70 Btu/W.h

Performance Points rated at AHRI Ambient Relief

Point #	% Load	Unit Capacity ton	Unit Input Power kW	Unit Efficiency (EER) Btu/W.h	Evaporator Fluid Flow gpm	Evaporator Pressure Drop ft H_2O	Evaporator Entering Fluid Temperature °F	Evaporator Leaving Fluid Temperature °F	Condenser Ambient Air Temperature °F	Condenser Altitude ft
1	100.0	134.3	164.2	9.800	291.8	8.20	55.00	44.00	100.0	0.000
2	75.0	100.8	93.70	12.90	291.8	8.20	52.30	44.00	83.1	0.000
3	50.0	67.20	48.90	16.50	291.8	8.20	49.50	44.00	66.3	0.000
4	25.0	33.60	21.90	18.40	291.8	8.20	46.80	44.00	55.0	0.000

Supplemental Performance Data for Unit Operation at AHRI Conditions

Performance Points at AHRI Standard Condition

Capacity	Input Power	Efficiency (EER)	IPLV.IP* (EER)
138.9 ton	157.0 kW	10.60 Btu/W.h	15.70 Btu/W.h

Performance Points rated at AHRI

Point #	% Load	Unit Capacity ton	Unit Input Power kW	Unit Efficiency (EER) Btu/W.h	Evaporator Fluid Flow gpm	Evaporator Entering Fluid Temperature °F	Evaporator Leaving Fluid Temperature °F	Condenser Ambient Air Temperature °F	Condenser Altitude ft
1	100	138.9	157.0	10.60	331.6	54.00	44.00	95.0	0.000
2	75	104.2	91.60	13.60	331.6	51.50	44.00	80.0	0.000
3	50	69.50	49.10	17.00	331.6	49.00	44.00	65.0	0.000
4	25	34.70	22.60	18.40	331.6	46.50	44.00	55.0	0.000

** IPLV reflects AHRI standard rating conditions and does not change with user defined conditions*

Sound (*without insulation*)

Sound Pressure (*at 30 feet*)

63 Hz dB	125 Hz dB	250 Hz dB	500 Hz dB	1 kHz dB	2 kHz dB	4 kHz dB	8 kHz dB	Overall dBA
68	69	69	65	61	60	61	56	**69**

Sound Power

63 Hz dB	125 Hz dB	250 Hz dB	500 Hz dB	1 kHz dB	2 kHz dB	4 kHz dB	8 kHz dB	Overall dBA
95	98	93	94	93	87	86	85	**97**

Octave band is non 'A' weighted and overall readings are 'A' weighted. Sound data rated in accordance with AHRI Standard-370.

Physical

Unit Length*	Height	Width*	Shipping Weight*	Operating Weight*
238 in	99 in	88 in	8509 lb	8628 lb

Shipping and Operating Weights are based on a heaviest case Dual Pump package configuration plus below Option weights only and do not include the weights of any Accessories. Length and Width Dimensions are based on unit cabinet dimensions and do not include piping connection and options. Contact Chiller Applications for additional information. **See Certified Drawings for details.*

Option Weights

Louvers:	500 lb
Total:	500 lb

Technical Data Sheet for CH-1

Pump Package

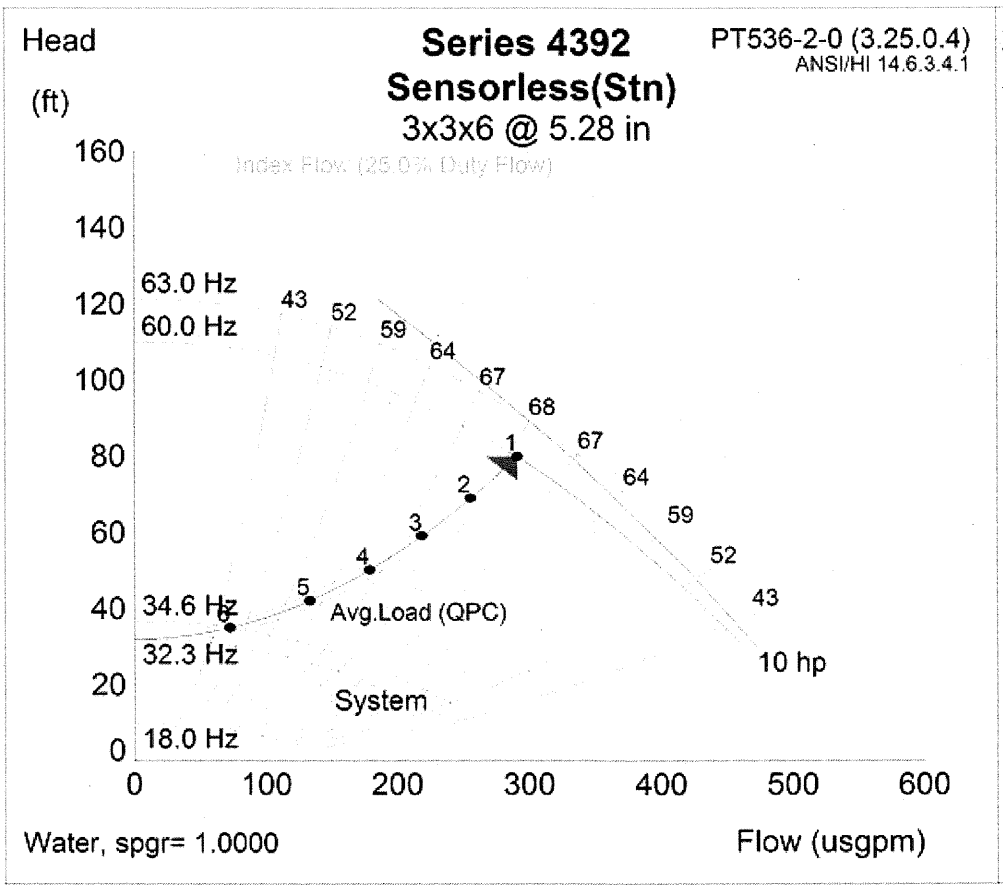
Pump Type	Power Supply	Pump Starter Type	Pump Dry Weight	Total Unit Operating Weight*
Duplex	Unit Supplied	Variable Speed	1454 lb	8628 lb
Motor RPM	**Motor FLA**	**Line Reactor**		**Pressure Gauges**
3600 rpm	14.0 A	Included		Included
Motor Horsepower	**Final Impeller Diameter**	**Total Flow**		**Total Head Pressure***
10.0 hp	5.28 in	291.8 gpm		80.0 ft H_2O

** Including Chiller*

Sound data and chiller performance data do not include operation with Pump Package.

See Certified Drawing for Connection Piping Sizing.

Pump Curve



--- Admin Data ---
Tag Num:
Service:
Location:

--- Motor Data ---
Motor Size: 10 hp

--- Design Duty Point ---
Flow: 291.799988 usgpm
Head: 79.961693 ft
Impeller: 5.28 in

--- Control Data ---
1. Hmax @ 60.0 Hz:
• 291.799988 @ 79.961693, 8.69 hp
2. Control (QPC) @ 54.9 Hz:
• 256.258728 @ 68.986237, 6.58 hp
3. Control (QPC) @ 49.8 Hz:
• 219.202911 @ 59.058857, 4.85 hp
4. Control (QPC) @ 44.7 Hz:
• 179.249817 @ 50.088909, 3.43 hp
5. Control (QPC) @ 39.7 Hz:
• 133.688522 @ 42.055172, 2.28 hp
6. Index @ 34.6 Hz:
• 72.949997 @ 34.983238, 1.35 hp
7. Hmin: 31.984674 ft 32.3 Hz:
• Setting= 40.00% Hmax

Technical Data Sheet for CH-1

Electrical

Unit Electrical Data

Voltage	Starter Type	Fan Motor Quantity	LRA Fan Motor (each)	FLA Fan Motors (each)
460 / 60.0 / 3	Across the Line	10	18A	3.6A

Power Connection Type:	Single Point Disconnect Switch with Circuit Protection
Short Circuit Current Rating:	5 kA
Phase Voltage:	Phase & Under/Over Voltage Protection with LED

Single Point Power Connection

MCA:	323 A
Fuse Size (*recommended*):	350 A
Fuse Size (*maximum*):	350 A
Connector Wire Range:	(2) 3/0-500

Compressor Electrical Data

Compressor Type	Compressor Quantity	Starter Type
Scroll	4	Across the Line

Circuit #:	1		2	
Compressor #:	1	3	2	4
RLA:	54.5 A	73 A	54.5 A	73 A
Inrush Current:	310 A	408 A	310 A	408 A

Note: Power wiring connections to the chiller may be done with either copper or aluminum wiring. Wire should be sized per NEC and/or local codes. Wire sizing and wire count must fit in the power connection lug sizing listed in latest installation manual. Please contact your local sales office for more information.

Options

Basic Unit

Suction Shut-off Valve:	Included

Electrical

Ground Fault:	Unit Ground Fault Protection
Unit Options:	115V Convenience Outlet
Water Flow Indicator:	Thermal Dispersion Type

Warranty

Unit Startup	Domestic
Standard Warranty:	1st Year Entire Unit Parts only

AHRI Certification

Certified in accordance with the AHRI Air-Cooled Water-Chilling Packages Using Vapor Compression Cycle Certification Program, which is based on AHRI Standard 550/590 (I-P) and AHRI Standard 551/591 (SI). Certified units may be found in the AHRI Directory at www.ahridirectory.org

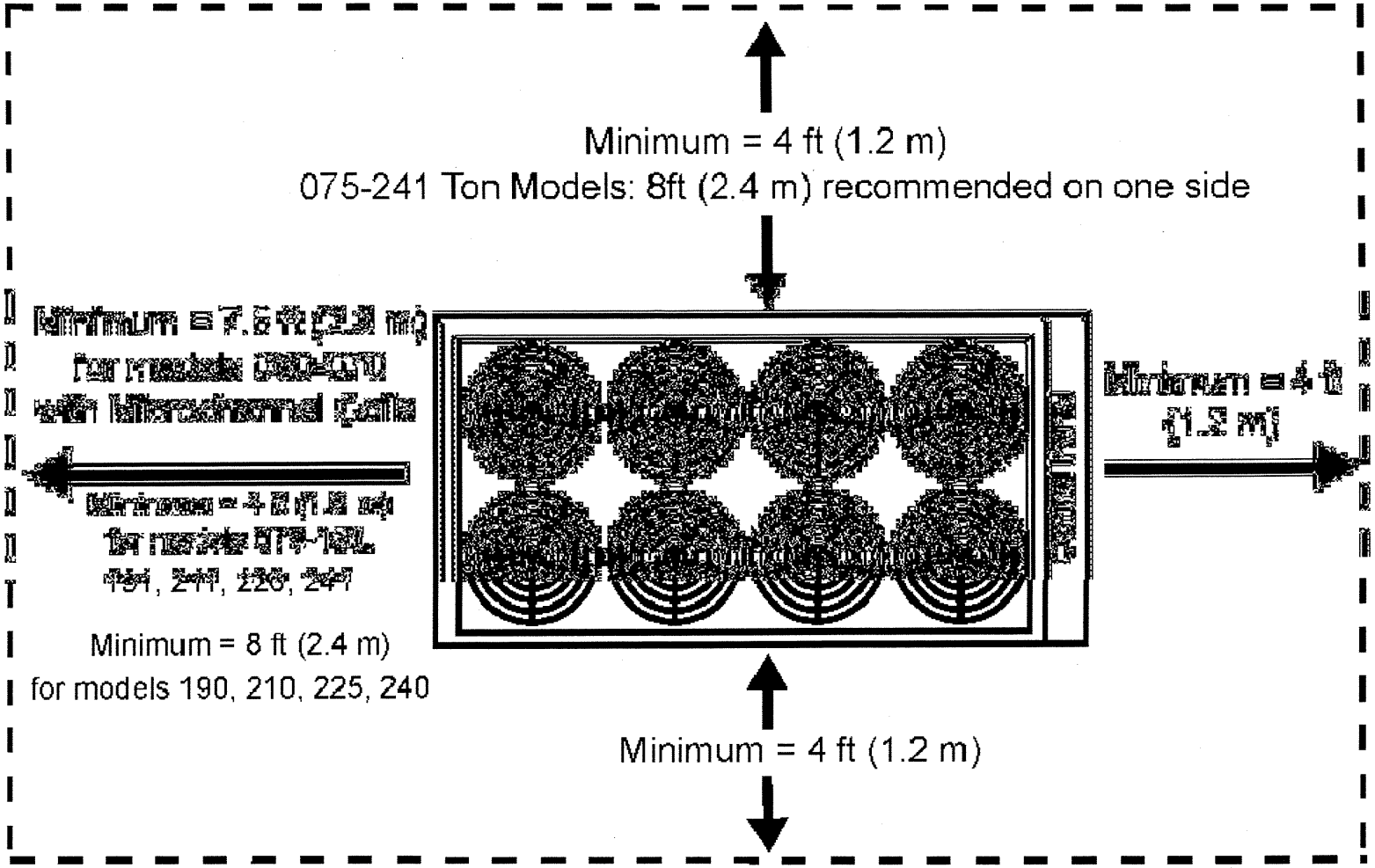
Accessories

Optional

Part Number	Description
334704758	Base Grilles; AGZ: Pump Package, 140-180E
334704753	Condenser Grilles; AGZ: Pump Package, 140-180E
331703514	Air Separator; AGZ & AGS: Pump Package, with Strainer, 5in NPT, 70-380 gpm
331703302	Pump Gauge; AGZ & AGS: Pump Package, Head Range 51-90 ft
193474033	Pump Motor Line Reactor Kit; AGZ: Pump Package, 030-180E, 025-190D, Dual Circuit, 10 HP, 460-480V

AGZ-E Service Clearance

0A



Product Drawing	Unit Tag: CH-1			Sales Office: Norman S. Wright-Climatec Mechl			DAIKIN
Product: Air-Cooled Scroll Chiller	Project Name: Muir ES Chiller Replacement			Sales Engineer: Brandon Musich			13600 Industrial Park Blvd. Minneapolis, MN 55441
Model: AGZ-E	July 06, 2017	Ver/Rev:	Sheet: 1 of 1	Scale: NTS	Tolerance: +/- 1.0"	Dwg Units: in [mm]	www.DaikinApplied.com Software Version: 07.60

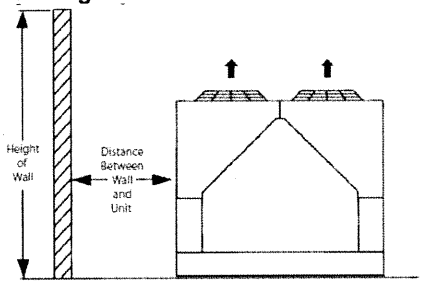
0A

AGZ-E Close Spacing Performance

Case 1: Building or Wall on One Side of Unit

Assumes a solid height wall taller than unit. Refer to Case 4 for partial wall openings.

Building or Wall on One Side of Unit



For models AGZ030-100E, maintain a 4 feet minimum from a wall of any height.

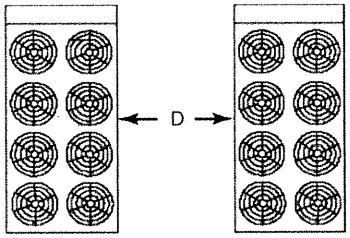
For models AGZ110-130E, maintain a 6 feet minimum from a wall of any height.

For models AGZ140-241E, maintain an 8 feet minimum from a wall of any height.

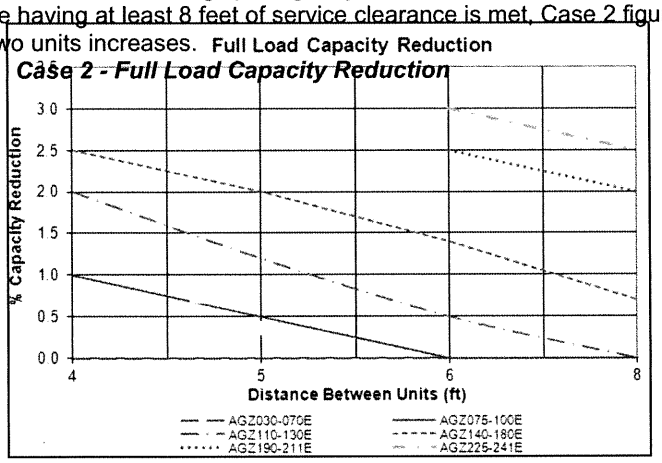
Case 2: Two Units, Side-by-Side

For models 030-180, there must be a minimum of 4 feet between two units placed side-by-side; however, performance may be affected at this distance. For models 190-211, the minimum is 6 feet as closing spacing may cause air recirculation and elevated condenser pressure. Assuming the requirement of one side having at least 8 feet of service clearance is met, Case 2 figures show performance adjustments as the distance between two units increases.

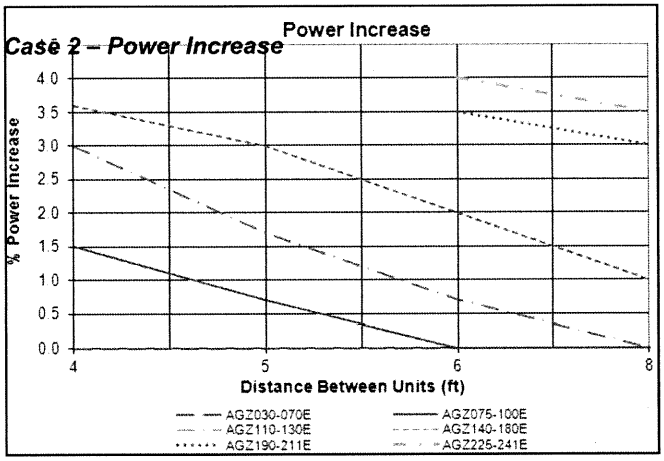
Two Units, Side-by-Side



Case 2 - Full Load Capacity Reduction



Case 2 – Power Increase



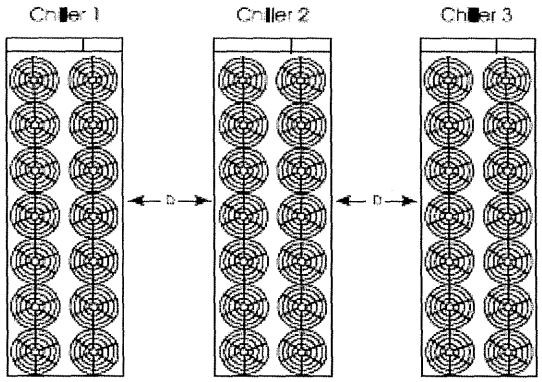
Product Drawing	Unit Tag: CH-1			DAIKIN		
Product: Air-Cooled Scroll Chiller	Project Name: Muir ES Chiller Replacement			13600 Industrial Park Blvd. Minneapolis, MN 55441		
Model: AGZ-E	Sales Office: Norman S. Wright-Climatec Mechl			www.DaikinApplied.com		Software Version: 07.60
Sales Engineer: Brandon Musich	July 06, 2017	Ver/Rev:	Sheet 1 of 1	Scale: NTS	Tolerance: +/-1.0"	Dwg Units: in [mm]

AGZ-E Close Spacing_Drawing for CH-1

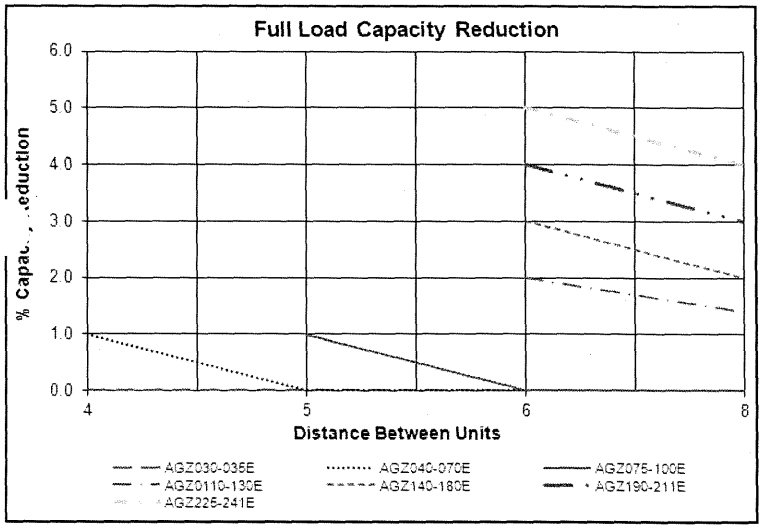
Case 3: Three or More Units, Side-by-Side

For all models, there must be a minimum distance between any units placed side-by-side; however, performance may be affected at this distance. Minimum distances are: models 030 to 070 - 4 feet, models 075 to 100 - 5 feet, models 110 to 241 - 6 feet. The Case 3 charts below depict Case 3 performance adjustments as the distance between units increases. Data shown is for the middle unit with a unit on each side. See Case 2 adjustment factors for the two outside units.

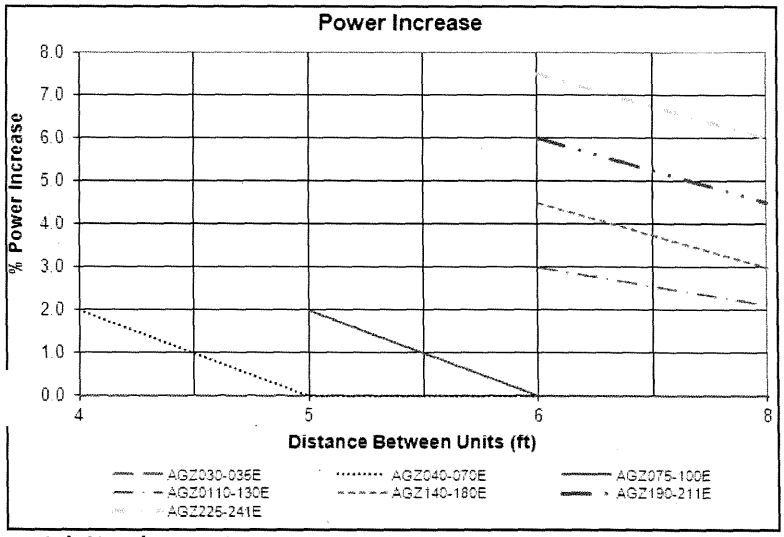
Three or More Units, Side-by-Side



Case 3 – Full Load Capacity Reduction



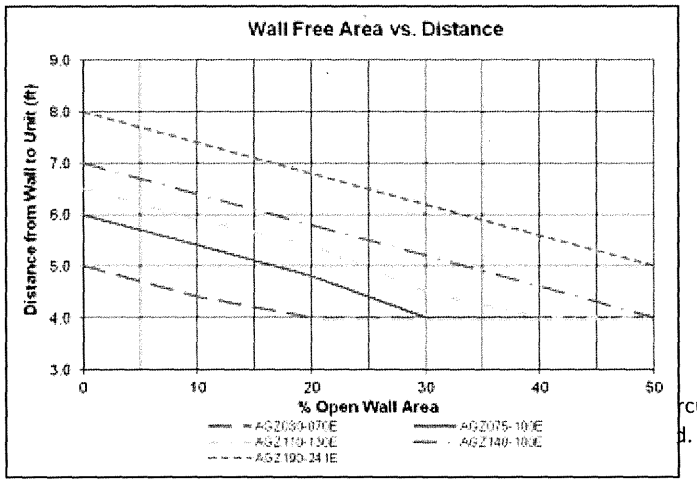
Case 3 – Power Increase



Case 4: Open Screening Walls

Decorative screening walls are often used to help conceal a unit either on grade or on a rooftop. When possible, design these walls such that the combination of their open area and distance from the unit (see chart below) do not require performance adjustment. If the wall opening percentage is less than recommended for the distance to the unit, it should be considered as a solid wall. It is assumed that the wall height is equal to or less than the unit height when mounted on its base support. If the wall height is greater than the unit height, see Case 5: Pit Installation for performance adjustment factors. The distance from the sides of the unit to the side walls must be sufficient for service, such as opening control panel doors. For uneven wall spacing, the distance from the unit to each wall can be averaged providing no distance is less than 4 feet. Values are based on walls on all four sides.

Case 4 - Allowable Wall Open Area



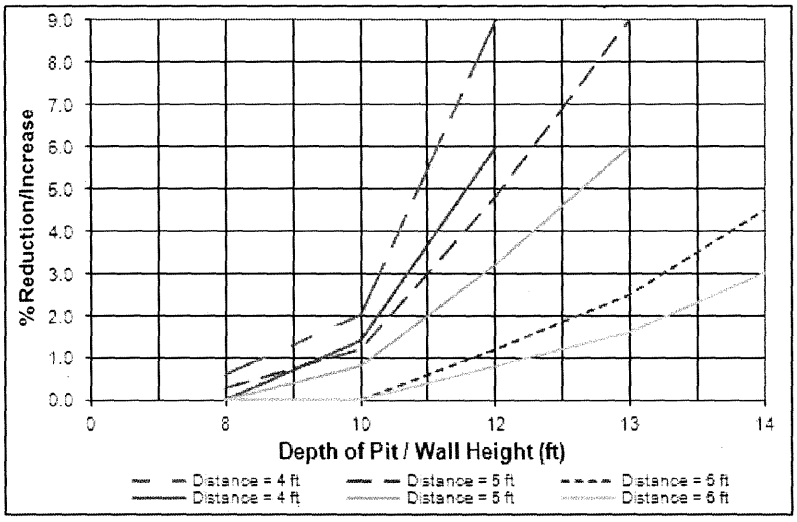
rculation and restriction and require care that sufficient air clearance is
d. A solid wall surrounding a unit is substantially a pit and this data should

Steel grating is sometimes used to cover a pit to prevent accidental falls or trips into the pit. The grating material and installation design must be strong enough to prevent such accidents, yet provide abundant open area to avoid recirculation problems. Have any pit installation reviewed by the Daikin Applied sales representative prior to installation to ensure it has sufficient air-flow characteristics and approved by the installation design engineer to avoid risk of accident.

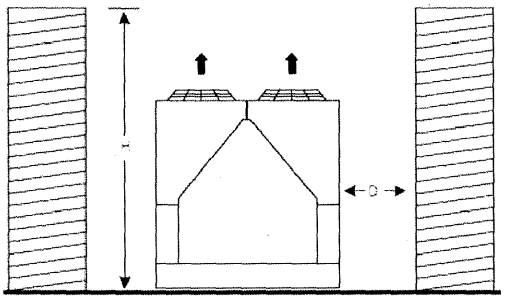
Models AGZ030-070E:

The Case 5 figures for models AGZ030-070E show adjustment factors for pit/wall heights of 4 feet, 5 feet, and 6 feet.

Case 5 - Full Load Capacity Reduction and Power Increase (AGZ030E-070E)



Case 5- Pit Installation



KEY:

- - - - - - - - - - : ***Power Increase***

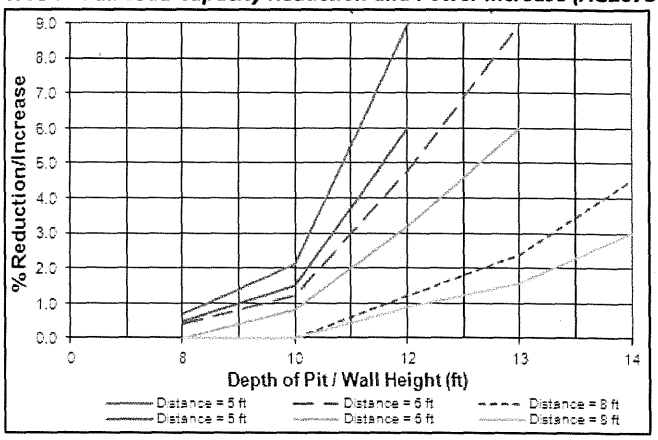
_____: ***Capacity Reduction***

AGZ-E Close Spacing_Drawing for CH-1

Models AGZ075-130E:

The Case 5 figures for models AGZ075-130E show adjustment factors for pit/wall heights of 5 feet, 6 feet, and 8 feet.

Case 5 - Full Load Capacity Reduction and Power Increase (AGZ075-130E)



KEY:

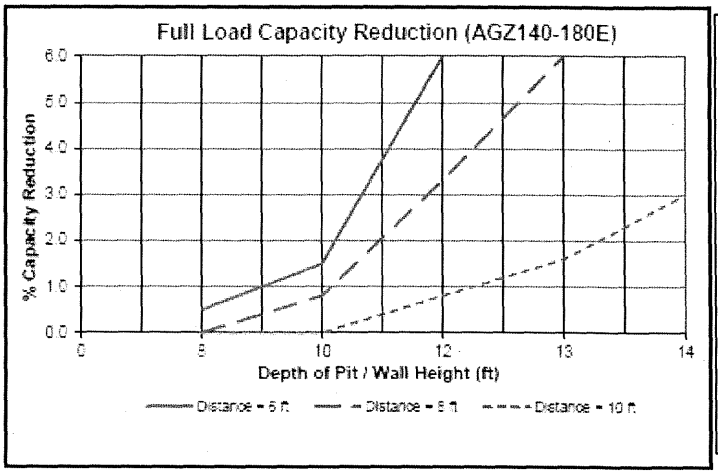
- - - - - - - - - - : ***Power Increase***

_____: ***Capacity Reduction***

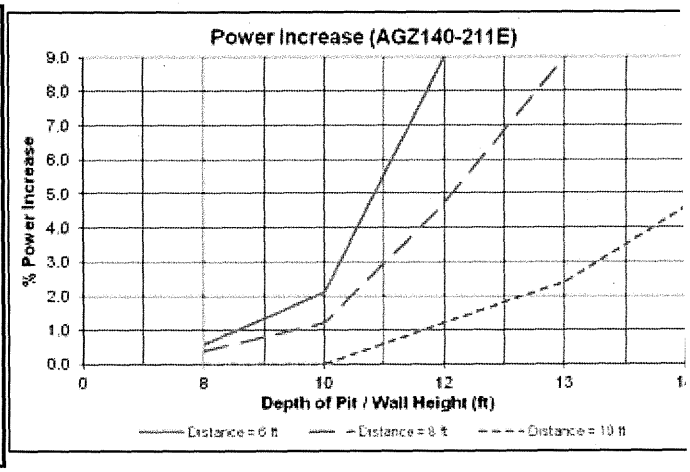
Models AGZ140-241E:

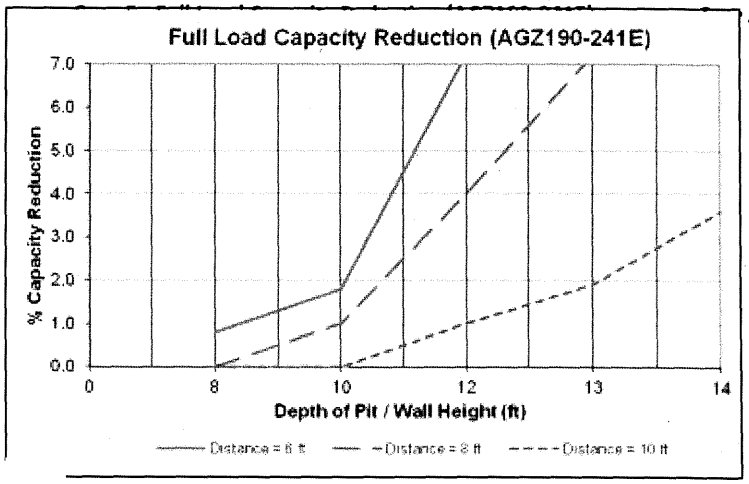
The Case 5 figures for models AGZ140-241E show adjustment factors for pit/wall heights of 6 feet, 8 feet, and 10 feet.

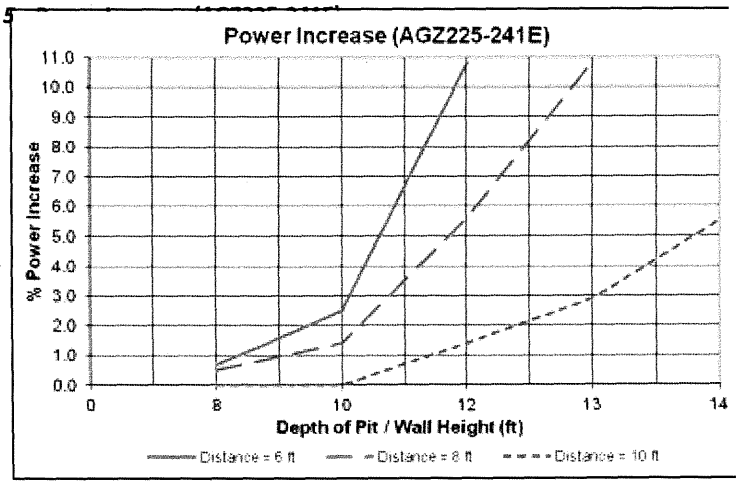
Case 5 - Full Load Capacity Reduction (AGZ140-180E)



Case 5 - Power Increase (AGZ140-211E)







AGZ-E Guards: Condenser Coil Louvers, Base Wire Grilles, Painted Base

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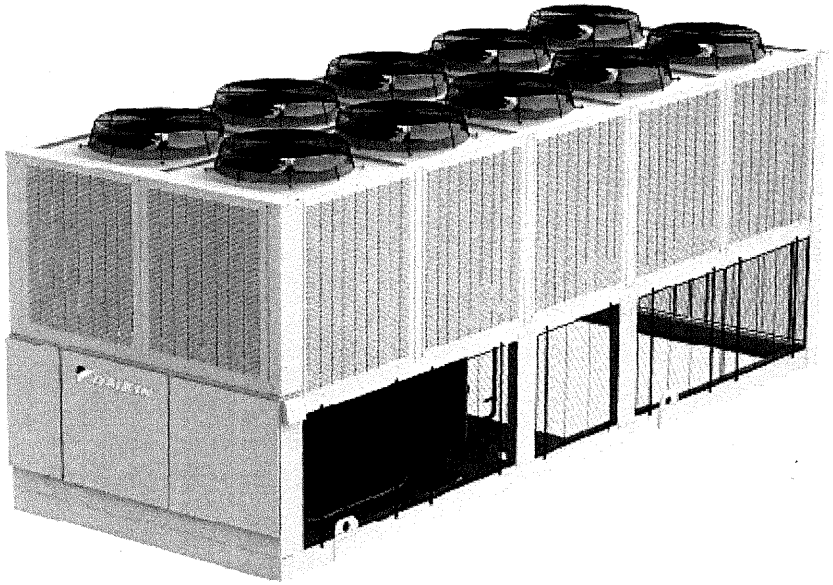


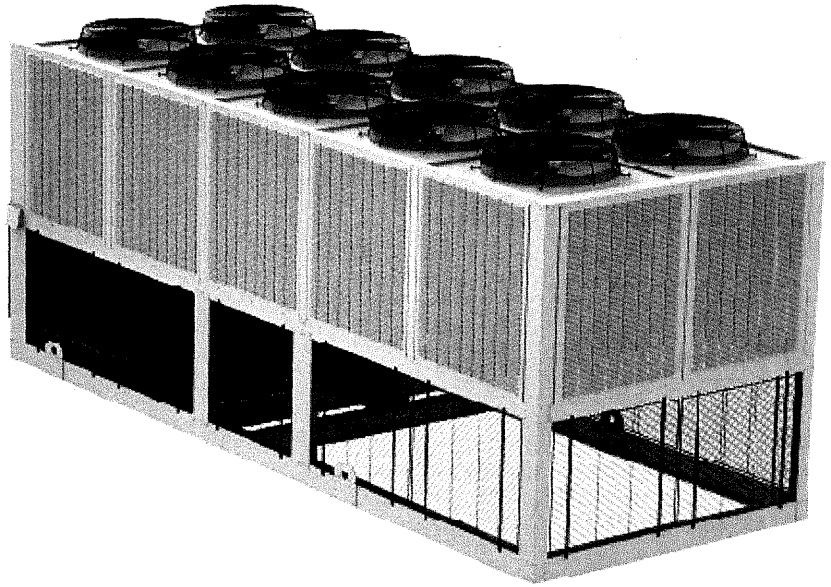


Diagram Notes
Diagram simulates wrap, grille and louver options as selected only. Refrigeration components may vary depending on selected options.

Product Drawing	Unit Tag: CH-1			Sales Office: Norman S. Wright-Climatec Mechl		
Product: Air-Cooled Scroll Chiller	Project Name: Muir ES Chiller Replacement			Sales Engineer: Brandon Musich		
Model: AGZ140-180E	July 06, 2017	Ver/Rev:	Sheet: 1 of 1	Scale: N/A	Tolerance: N/A	Dwg Units: N/A

DAIKIN
13600 Industrial Park Blvd. Minneapolis, MN 55441
www.DaikinApplied.com Software Version: 07.60

No change to this drawing may be made unless approved in writing by Daikin Applied. Purchaser must determine that the equipment is fit and sufficient for the job specifications.

AGZ140-180E_CndLuv_BsGrl_PntBs_Drawing for CH-1

AGZ140E (Microchannel Condenser- Dual Pum

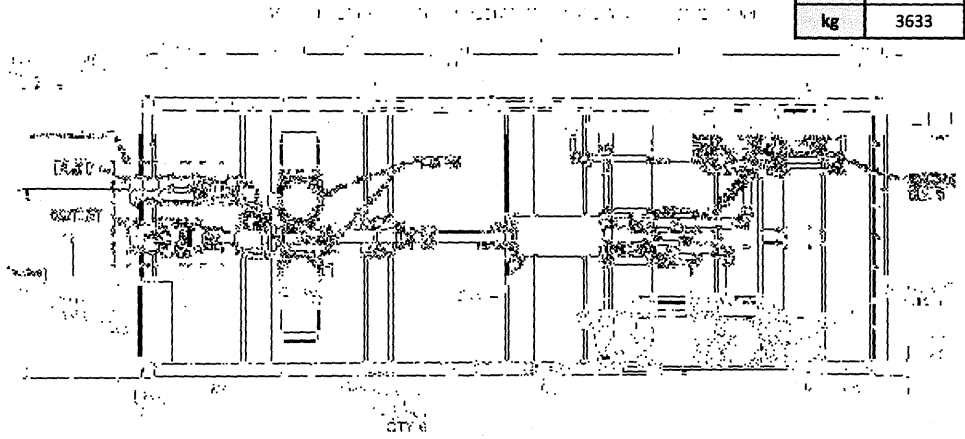
Unit Dimensions

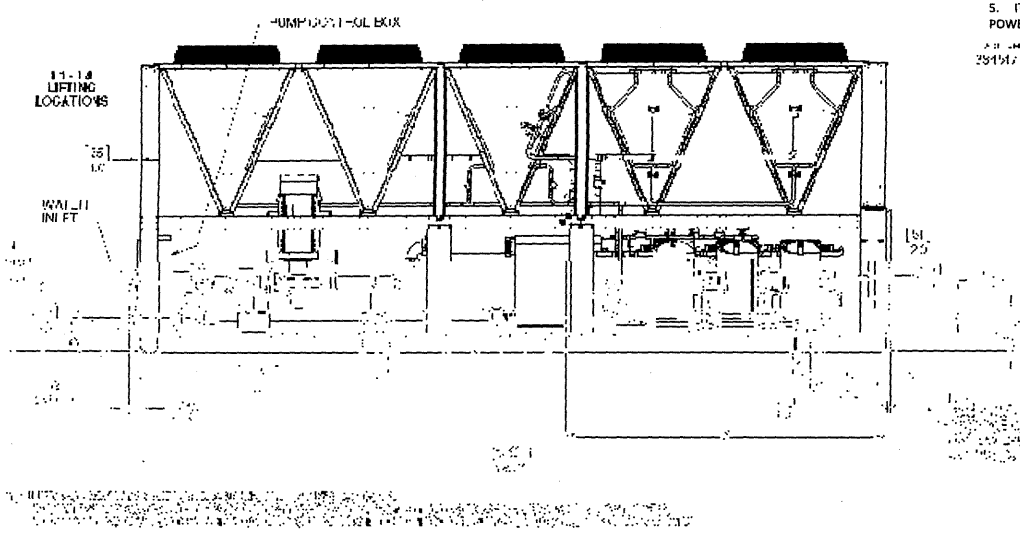
Unit Weight Data														
Units	Weight		Lifting Weight				Mounting Weight							
	Shipping	Operating	L1	L2	L3	L4	M1	M2	M3	M4	M5	M6	M7	M8
lb	8009	8128	1694	1678	2330	2308	1472	1458	1091	1081	846	838	674	667
kg	3633	3687	768	761	1057	1057	668	661	495	490	384	380	306	303

Unit and Center of Gravity Dimensions			
Units	Center of Gravity		
	X	Y	Z
in	43.8	40.7	103.7
mm	1113	1034	2634

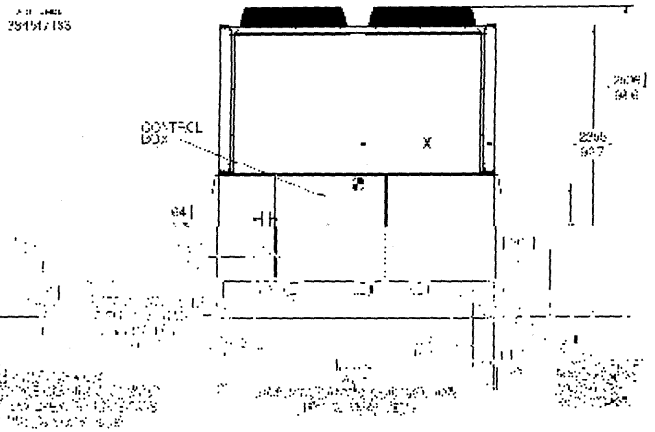
NOTE

A water strainer must be installed at the inlet of the evaporator to protect it from damage. Please refer to the IOM for additional details.





5. IT IS RECOMMENDED THAT THE SIDE LOCATIONS BE USED FOR POWER ENTRY WIRE SIZES LARGER THAN 350 MCM.



AGZ140E_PPKG_MCC_Dual_Drawing for CH-1

Product Drawing	Unit Tag: CH-1			Sales Office: Norman S. Wright-Climatec Mechl			DAIKIN
Product: Air-Cooled Scroll Chiller	Project Name: Muir ES Chiller Replacement			Sales Engineer: Brandon Musich			13600 Industrial Park Blvd. Minneapolis, MN 55441
Model: AGZ140E	July 06, 2017	Ver/Rev:	Sheet: 1 of 1	Scale: NTS	Tolerance: +/- 1.0"	Dwg Units: in [mm]	www.DaikinApplied.com Software Version: 07.60

AGZ030-241E With Pumps Single-Point Connection Field Wiring Diagram

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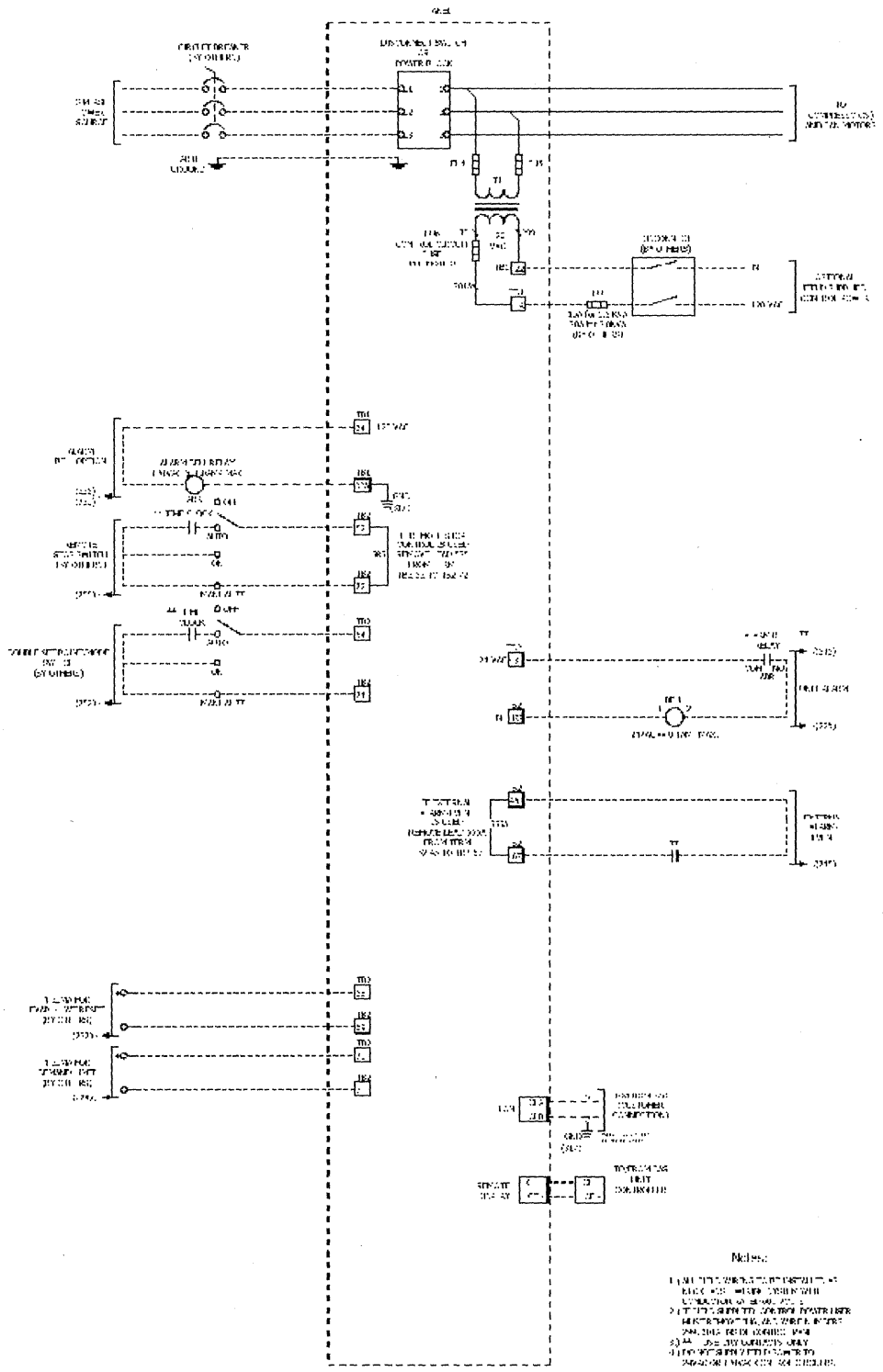

Field Wiring Diagram	Unit Tag: CH-1			DAIKIN		
Product: Air-Cooled Scroll	Project Name: Muir ES Chiller Replacement			13600 Industrial Park Blvd. Minneapolis, MN 55441		
Model: AGZ030-241E Single-Point	Sales Office: Norman S. Wright-Climatec Mechl			www.DaikinApplied.com	Software Version: 07.60	
Sales Engineer: Brandon Musich	July 06, 2017	Ver/Rev:	Sheet 1 of 1	Scale: N/A	Tolerance: N/A	Dwg Units: N/A