

Section 00 0101

Project Title Page

PROJECT MANUAL

FOR:

**Azalea House Child Care Center
Oregon State University
1050 SW Madison Ave
Corvallis, Oregon**

DATE: 08 Apr 2024

PREPARED BY:

Rowell Brokaw Architects

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SECTION 01 1100
SUMMARY OF WORK

PART 1 GENERAL**1.01 SUMMARY OF WORK**

- A. The Work Contract consists of the renovation of the Azalea Child Care Center on the Oregon State University campus. Work includes a full build-out of the existing unoccupied 2nd floor with two new classrooms and additional office and support spaces. Provide new MEPF serving this space. The first-floor scope includes the installation of cooling, demolition, and patching to support 2nd-floor work. Exterior work includes a new 2nd-floor roof deck, exterior stairs, and two canopy structures. All windows will be replaced. Interior and exterior painting of new and existing painted surfaces.
- B. Work shall be started within ten (10) calendar days after signing of Contract on behalf of Oregon State University. The Contract may not be signed prior to approval of the Contractor's Certificate of Insurance by Construction Contract Administration (CCA), Oregon State University.

1.02 CONTRACTORS USE OF PREMISES

- A. Contractor shall limit use of the Premises for work and storage to allow for:
 - 1. Owner occupancy, day and night.
 - 2. Public use, day and night.
 - 3. Security.
 - 4. Safe entry and exit for vehicles and pedestrians.
 - 5. Fire egress.
- B. Coordinate all operations with the Owner's Authorized Representative during the construction period. A 96 hour notification is required prior to scheduled utility shutdowns or street closures, but more lead time is often required to schedule around other critical activities.
- C. Limit Contractor's employee parking to locations designated at the Pre-construction Conference.

1.03 OWNER OCCUPANCY

- A. The Owner will occupy the Premises during the entire period of construction for the conduct of normal operations. Cooperate with Owner's Authorized Representative in construction operations to minimize conflict and to facilitate the Owner's usage especially in the following areas:
 - 1. Restricted access and parking.
 - 2. Use of stairs.
 - 3. Storage space availability.
- B. Conduct operations in such a way to ensure the least inconvenience to the general public, including:
 - 1. Limitations and easements.
 - 2. Emergency vehicle access.
 - 3. Building access to the public, day and night.

1.04 ASBESTOS AND OTHER HAZARDOUS MATERIAL

- A. The Owner has made a reasonable attempt to locate and identify asbestos or other hazardous material that may be encountered during the course of the Work.
- B. If the Contractor observes or suspects the existence of asbestos, polychlorinated biphenyl (PCB) or other hazardous materials in the structure or components of the building, the Contractor shall immediately stop work and notify the Owner's Authorized Representative.

- C. The Owner will arrange for the removal of asbestos, polychlorinated biphenyl (PCB) or other hazardous materials as required by Facilities Services personnel or by separate contract.
- D. Schedule ten (10) days of slack or "down" time for the removal of hazardous materials without penalty to Owner for the delay of the Contract.

1.05 LEAD BASED PAINT

- A. The Owner may have tested existing paint in the project area and if levels are found the following conditions apply.
- B. Contractor shall remove paint as specified for surface preparation and capture removed material for disposal.
- C. Contractor shall follow OSHA guidelines involving exposure to workers.
- D. Owner will provide containers for Contractor's use at project site.
- E. Contractor shall comply with the requirements of DEQ and EPA and shall submit a lead abatement plan.
- F. Contractor shall separate lead contaminated material from effluent and water.
- G. Owner will dispose of lead paint and effluent resulting from stripping operation.
- H. Soil contaminated by stripping operations shall be replaced with topsoil.

END OF SECTION 01 1100

SECTION 01 2300
ALTERNATES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. The alternates described in this Section may be exercised at the option of the Owner within 60 days of the execution of the Contract.
- B. It is generally the practice of the Owner to exercise alternates in numerical order.
- C. The Owner reserves the right to accept the alternates without regard to order or sequence; but, such acceptance shall not impair the selection of a low, responsible and responsive bidder to whom the Contract may be awarded under an equitable bid procedure.

1.02 QUALITY ASSURANCE

- A. For each alternate which is accepted, coordinate the work of the various trades involved, and modify surrounding work as required to complete the project as intended.
- B. In the change-in-price figure for each alternate, include incidental costs which are attributable to adjustments in the work of other trades which may be required to achieve the contemplated and final conditions.
- C. Questions:
 - 1. If there is a question regarding the extent, scope, nature, or intent of the alternates, contact the Owner's Authorized Representative for clarification.
 - 2. Failure on the part of the Contractor to clarify any unclear items shall not relieve the Contractor of the responsibility for performing the selected alternates in accordance with the intent and requirements of the Project Manual and Drawings.
 - 3. The description of the alternates hereinafter is qualitative and not quantitative; the Contractor shall determine the quantities of labor and materials and the extent of same required to execute the selected alternates in accordance with the intent and requirements of the Project Manual and Drawings.
 - 4. The applicable Sections of the Specifications apply to the work under each alternate.

1.03 LIST OF ALTERNATES

- A. Alternate 1: South Shade Structure
 - 1. Base Bid: Provide south canopy structure per documents.
 - 2. Alternate Bid: Eliminate shade structure. Re-install (e) retractable canopy.
- B. Alternate 2: Full replacement of existing wood casement windows.
 - 1. Base Bid: At existing wood casement windows, replace (e) wood sash with new vinyl windows in existing wood frames.
 - 2. Alternate Bid: Remove existing wood windows to rough opening. Provide new vinyl windows matching existing configuration.
- C. Alternate 3: Fixed single pane glazing at 1st floor.
 - 1. Base Bid: Replace the single pane glazing in the 1st floor large fixed-glazed assemblies with new vinyl windows in the existing wood frame.
 - 2. Alternate Bid: Replace the single pane glazing in the 1st floor large fixed-glazed assemblies with new 1" IGU. Wood frames and wood louvers are to remain.

END OF SECTION 01 2300

SECTION 01 2476
APPLICATIONS FOR PAYMENT

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Work of this Section includes forms and procedures for progress payments.
- B. Related work specified elsewhere.
 - 1. For the primary discussion of payments, refer to OSU General Conditions, Section E, as supplemented.
 - 2. In compliance with OSU General Conditions, Section K, no payments beyond 75% will be made by the Owner before draft Operation and Maintenance Manuals have been received for review by the Owner.

1.02 APPLICATION FORMS

- A. For applications for payment, use sample Contract Payment Request (see below), contract payment request on company letterhead, or AIA Document G702, supported by AIA Document G703, Continuation Sheet, or similar document.
- B. Prepare the Schedule of Values in such a manner that each major item of Work and each subcontracted item of Work is shown as a line item broken down in terms of material and labor costs on AIA Document G703, Application Certification of Payment, Continuation Sheet or similar format. The sample continuation sheet shall be the minimum Schedule of Values breakdown.
- C. The Schedule of Values shall be submitted for review by the Owner prior to the first application for payment; and may be used when, and only when, accepted in writing by the Owner.
- D. Payment request is to include the Contractor's Federal Tax Identification number and return address.

1.03 PAYMENTS

- A. The Owner will make progress payments on account of the Contract once monthly for the scheduled duration of the project (i.e. three (3) payments on a three-month project), based on the value of work accomplished or materials on the job site, as stated in the Schedule of Values on the Application and Certificate Payment.
- B. Complete and forward Application to the Owner on or about the 15th day of each month for work performed the previous month and include certified payroll statements as specified in the OSU General Conditions.
- C. Submit one (1) copy of forms requesting payment to the Owner.
- D. Payments will be made on protected materials on hand at the job site properly stored, protected, and insured.
- E. Estimated quantities shall be subject to the Owner's review and judgment.

1.04 EARLY PURCHASE AND PAYMENT OF MATERIALS AND EQUIPMENT

- A. Order materials and equipment requiring a long lead or waiting time early so as not to delay progress of the Work.
- B. The Contractor will be reimbursed for early order materials or equipment upon receipt and verification of quality and quantity against submittals and shipping documents by the Owner's Authorized Representative.
- C. Receipt shall be to the job site or stored at Owner's other premises in an orderly and safe manner, secured from normal weather damage.

D. Security remains the responsibility of the Contractor.

END OF SECTION

CONTRACT PAYMENT REQUEST

DATE: _____

TO: UNIVERSITY FINANCIAL SERVICES

OREGON STATE UNIVERSITY

3015 SW WESTERN BLVD

CORVALLIS, OR 97333

PAYMENT REQUEST NO. _____ CONTRACT NO. _____ PERIOD FROM _____ TO _____

PROJECT: _____

ORIGINAL CONTRACT AMOUNT \$ _____

CHANGE ORDERS (NET AMOUNT) \$ _____

CONTRACT TOTAL TO DATE \$ _____

=====

TOTAL COMPLETED AND STORED TO DATE \$ _____

LESS RETAINAGE (5%), IF APPLICABLE \$ _____

TOTAL EARNED, LESS RETAINAGE (IF APPLICABLE) \$ _____

LESS PREVIOUS PAYMENTS \$ _____

NET AMOUNT DUE THIS REQUEST \$ _____

THE UNDERSIGNED CONTRACTOR CERTIFIES THAT, TO THE BEST OF HIS/HER KNOWLEDGE, INFORMATION, AND BELIEF, THE WORK COVERED BY THIS REQUEST HAS BEEN COMPLETED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, THAT ALL AMOUNTS HAVE BEEN PAID FOR WORK FOR WHICH PREVIOUS APPLICATIONS FOR PAYMENT WERE ISSUED AND PAYMENTS RECEIVED FROM THE OWNER, AND THAT THE AMOUNT SHOWN HEREIN IS NOW DUE.

CONTRACTOR: _____

BY: _____ **DATE:** _____

FEDERAL TAX ID NUMBER: _____

ADDRESS: _____

CONTINUATION SHEET

NOTES:

Amounts are stated to the nearest penny.
Use Column I on Contracts where variable retainage for line items may apply, or if retainage is required.
Change Orders are usually listed as the last items of the basic schedule.

Project Name: _____
Application No.: _____
Date: _____
Period To: _____
WRN No.: _____

A Item No.	B Description of work	C Scheduled Value	D Work Completed		E This Period	F Materials Presently Stored (Not in D or E)	G		H Balance to Finish (C-G)	I Retainage
			From Previous Applications				TOTAL Completed & Stored (D+E+F)	% Completed (G/C)		
TOTALS										

SECTION 01 2500
PRODUCT SUBSTITUTION PROCEDURES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. General requirements for the Work in relation to substitutions and product options.
- B. Submit to the Owner's property insurance carrier shop drawings, samples, and product data (such as manufacturer's standard schematic drawings and other literature) when required by individual Specifications sections.
- C. Related Work Specified Elsewhere
 - 1. Instructions to Bidders.
 - 2. OSU General Conditions.

1.02 REQUESTS FOR SUBSTITUTIONS

- A. Requests for substitution of products in place of those specified shall be in accordance with Instructions to Bidders, and as specified herein.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Investigate proposed products and determine that they are equal or superior in all respects to products specified.
- B. Provide same guarantee for accepted substitutions as for products specified.
- C. Coordinate installation of accepted substitutions into the Work, making such changes as may be required for the Work to be complete in all respects.

1.04 SUBSTITUTIONS DURING BIDDING

- A. Submit two (2) copies of the following information with each request to the Owner:
 - 1. CSI substitution request form.
 - 2. Comparison of proposed substitution with product, material or system specified.
 - 3. Complete data, substantiating compliance of proposed substitution with the Contract Documents.
 - 4. Test numbers and supporting reports, indicating compliance with referenced standards.
 - 5. Evidence that warranty requirements are acceptable.
 - 6. Details indicating specific deviations proposed for the substitution.
 - 7. Reference and applicable Specification sections.
 - 8. Applicable product samples.
- B. All substitution requests shall be received in the Owner's office no less than ten (10) calendar days before bid opening. Requests received after this date will not be considered.

1.05 SUBSTITUTIONS DURING CONSTRUCTION

- A. Substitutions will normally not be considered after date of Contract except when required due to unforeseen circumstances.
- B. Within a period of thirty (30) days after date of Contract, the Owner may, at its option, consider formal written requests for substitution of products in place of those specified, when submitted in accordance with the requirements stipulated herein.
- C. One or more of the following conditions must be documented in any such request:
 - 1. Required for compliance with final interpretation of code or insurance requirements.
 - 2. Required due to unavailability of a specified product.
 - 3. Required because of the inability of the specified product to perform properly or to fit in the designated space.

- 4. Substitution would be substantially in the best interest of the Owner in terms of cost, time, or other considerations.

1.06 SUBSTITUTIONS NOT PERMITTED

- A. If implied on submittals without first requesting approval thereof.
- B. If acceptance will require substantial revision of the Contract Documents.

END OF SECTION

SUBSTITUTION REQUEST FORM

TO:

PROJECT:

SPECIFIED ITEM:

PAGE PARAGRAPH DESCRIPTION

THE UNDERSIGNED REQUESTS CONSIDERATION OF THE FOLLOWING:

PROPOSED SUBSTITUTION: _____

ATTACHED DATA INCLUDES PRODUCT DESCRIPTION, SPECIFICATIONS, DRAWINGS, PHOTOGRAPHS, PERFORMANCE AND TEST DATA ADEQUATE FOR EVALUATION OF THE REQUEST; APPLICABLE PORTIONS OF THE DATA ARE CLEARLY IDENTIFIED.

ATTACHED DATA ALSO INCLUDES DESCRIPTION OF CHANGES TO CONTRACT DOCUMENTS WHICH PROPOSED SUBSTITUTION WILL REQUIRE FOR ITS PROPER INSTALLATION.

THE UNDERSIGNED STATES THAT THE FOLLOWING PARAGRAPHS, UNLESS MODIFIED ON ATTACHMENTS, ARE CORRECT:

- 1. THE PROPOSED SUBSTITUTION DOES NOT AFFECT DIMENSIONS SHOWN ON DRAWINGS.**
- 2. THE UNDERSIGNED WILL PAY FOR CHANGES TO THE BUILDING DESIGN, INCLUDING ENGINEERING DESIGN, DETAILING AND CONSTRUCTION COSTS CAUSED BY THE REQUESTED SUBSTITUTION.**
- 3. THE PROPOSED SUBSTITUTION WILL HAVE NO ADVERSE EFFECT ON OTHER TRADES, THE CONSTRUCTION SCHEDULE, OR SPECIFIED WARRANTY REQUIREMENTS.**
- 4. MAINTENANCE AND SERVICE PARTS WILL BE LOCALLY AVAILABLE FOR THE PROPOSED SUBSTITUTION.**

THE UNDERSIGNED FURTHER STATES THAT THE FUNCTION, APPEARANCE AND QUALITY OF THE PROPOSED SUBSTITUTION ARE EQUIVALENT OR SUPERIOR TO THE SPECIFIED ITEM.

SUBMITTED BY:

FOR USE BY DESIGN CONSULTANT:

ACCEPTED ACCEPTED AS NOTED

NOT ACCEPTED RECEIVED TOO LATE

BY _____

DATE _____

REMARKS _____

ATTACHMENTS:

SECTION 01 3119
PROJECT MEETINGS

PART 1 GENERAL**1.01 PRE-CONSTRUCTION MEETING**

- A. Architect/Engineer/Designer, Contractor and Owner will meet prior to start of the Work (within seven (7) days after notice to proceed) to discuss at least the following topics and any others of mutual interest.
1. Schedule of Values
 2. Permit Status/tree protection/erosion control
 3. List of sub-contractors
 4. Job inspections.
 5. Early purchase of, and/or lead time requirements for material and equipment/prepurchase of equipment
 6. Monthly payment date/SOP for pay requests
 7. Portion of site to be occupied by construction.
 8. Parking/Staging areas
 9. Non-smoking campus requirements
 10. Maintenance of access and safety.
 11. Processing of field decisions and change orders
 12. Labor provisions/labor rates for subs
 13. Material submittals/deferred submittals
 14. Owner access during construction.
 15. Review of Contract Documents/review ADA requirements
 16. Coordination procedures and separate contracts.
 17. Progress schedules.
 18. Critical Work sequencing.
 19. Safety and emergency procedures/24 hour contact numbers
 20. Security procedures.
 21. Hazardous materials.
 22. Progress meetings.
 23. Contract close-out.
- B. Location of Meeting: Project site

1.02 PROGRESS MEETINGS

- A. The Contractor will schedule and administer progress meetings and will:
1. Prepare agendas.
 2. Schedule progress meetings, frequency, time and day to be determined during pre-construction meeting.
 3. Make physical arrangements for and preside at meetings.
 4. Record minutes and include decisions.
 5. Distribute copies of minutes to participants within four (4) days after meetings.
- B. Location of Meetings: Project site.
- C. Attendance:
1. The Owner or Owner's Authorized Representative.
 2. Contractor.
 3. Subcontractors affected by agenda.
 4. Project Architect/Engineer/as necessary.

5. Owner will attend meeting to ascertain Work is expedited consistent with progress schedule and with Contract Documents.
- D. Minimum Agenda:
1. Review and approve minutes from previous meeting.
 2. Review Work progress since previous meeting.
 3. Discuss field observations, and problems.
 4. Review delivery schedules, construction schedule, and identify problems which impede planned progress.
 5. Review proposed changes.
 6. Material submittals.
 7. Note all new subcontractors performing Work at the job site.

END OF SECTION 01 3119

SECTION 01 3323
SHOP DRAWINGS, PRODUCT DATA, SAMPLES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Submit to the Owner shop drawings, samples, and product data (such as manufacturer's standard schematic drawings and other literature) when required by individual Specifications sections.
- B. Related Work Specified Elsewhere
 - 1. Instructions to Bidders.
 - 2. OSU General Conditions.

1.02 SUBMITTAL SCHEDULING

- A. For items requiring review by the Owner only, submittals shall be sent to the Owner at least 15 calendar days before the date each is required for fabrication or installation.
- B. Submittals to be reviewed by Owner's consultants shall be sent to the Owner at least 20 calendar days before the date each is required for fabrication or installation.
- C. Submittals to be reviewed by Owner's property insurance carrier shall be sent to Owner as directed in individual specification sections.
- D. Submittals involving Substitution requests or other modifications requiring review by the Owner and/or the Owner's consultants shall be sent to the Owner at least 20 calendar days before the date each is required for fabrication or installation.

1.03 SUBMITTAL CONTENT AND FORMAT

- A. General Requirements:
 - 1. Shop Drawings: Submit in electronic format and, if requested by Owner's Authorized Representative, additional formats by request.
 - 2. Product Data: Submit electronically, and if requested by Owner's Authorized Representative, up to 6 hard copies.
 - 3. Samples: Submit the number and type stated in each Specification Section. Submit a minimum of three sets of color samples where color selection is required.
 - 4. Submittals shall include:
 - a. Date and revision dates return date requested.
 - b. Project title and number.
 - c. The names of the Contractor, subcontractor, supplier, and manufacturer.
 - d. Identification of product or material, with Specification Section number.
 - e. Relation to adjacent critical features of work or materials.
 - f. Field dimensions, clearly identified as such.
 - g. Applicable standards, such as ASTM number or Federal Specification.
 - h. Identification of deviations from Contract Documents, and for products accompanied by Substitution request as required by Section 01 25 00.
 - i. Contractor's stamp legibly signed, essentially as follows:
 - 1) The undersigned, acting on behalf of the Contractor, certifies that this submittal has been reviewed and is approved; products have been verified as being as specified, field measurements and field construction criteria have been or will be coordinated, and the submittal is in compliance with Contract Documents.
 - 5. Re-submission Requirements:
 - a. Revise initial drawings as required and resubmit as specified for initial submittal.

- b. Indicate on drawings any changes which have been made other than those requested by the Owner or the owner's consultants.
 6. The Owner may return without review any submittal not meeting the requirements listed above.
- B. Shop Drawings:
1. Present data in a clear and thorough manner.
 2. Details shall be identified by reference to sheet and detail, schedule or room numbers shown on Contract Documents.
 3. Structural items shall be identified by location in the completed structure. Identify details by reference to contract sheet and detail numbers.
 4. Minimum sheet Size: 8 ½ x 11".
- C. Product Data:
1. Manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations and other standard descriptive data:
 - a. Clearly mark each copy to identify pertinent product or models.
 - b. Show dimensions, weights, and clearances required.
 - c. Show performance data consisting of capabilities, ROM, KW, pressure drops, design characteristics and consumption; conforming as closely as possible to the test methods referenced in the Plans and Specifications.
 - d. Show wiring or piping diagrams and controls.
 2. Manufacturer's standard schematic drawings and diagrams:
 - a. Modify to delete information which is not applicable.
 - b. Supplement standard information to provide information specifically applicable to the Work.
- D. Samples:
1. Insure that samples are of sufficient size to indicate the general visual effect or color.
 2. Where samples must show a range of color, texture, finish, graining, or other property, submit sets of pairs illustrating the full scope of this range.
 3. One (1) sample or one (1) set of approved samples will be retained by the Owner; final work will be measured against approved samples.

1.04 QUALITY ASSURANCE

- A. Process submittals in ample time for review, as applicable, so as to not delay the Work. All submittals shall be received by the Owner within ten (10) days after pre-construction.

1.05 DEFINITIONS

- A. The Owner will mark reviewed materials as follows:
 1. "No Exception Taken," which means fabrication, manufacture and/or installation may proceed.
 2. "Make Revisions Noted," which means fabrication, manufacture and/or installation may proceed with revisions as noted.
 3. "Revise and Resubmit," which means that fabrication, manufacture and/or installation may not proceed.
 4. "Rejected," which means do not proceed; make arrangements for the review of the proposed Work with the Owner as soon as possible.

1.06 PROCESSING

- A. Review submittals, make necessary corrections, and become familiar with the content of the submittals.
- B. Mark each item with Contractor's stamp.

- C. Accompany submittals with a transmittal letter bearing the project name, Contractor's name, number of items, and other pertinent data.
- D. Keep one copy of each reviewed submittal on the job site at all times.
- E. Be responsible for obtaining and distributing prints of shop drawings to the various suppliers, and the Owner once review process has been completed. Make prints of reviewed shop drawings only from transparencies which carry the appropriate stamp and endorsement.

END OF SECTION 01 3323

SECTION 01 4213
ABBREVIATIONS AND SYMBOLS

PART 1 GENERAL**1.01 REQUIREMENTS INCLUDED**

- A. Words which may be found elsewhere in the Project Manual and Drawings are abbreviated in accordance with the standards set forth in the following table:

A/C - air conditioning
AB - anchor bolt
AC - asphaltic concrete
ACT - acoustical tile
AD - area drain
ADD - addendum
ADD'L - additional
ADH - adhesive
AFF - above finish floor
AGG - aggregate
AL - aluminum
ALLOW - allowable
ALT - alternate
ANOD - anodized
AP - access panel
APPRX - approximate
ARCH - architect(ural)
ASPH - asphalt
AUTP - automatic
AVE - avenue
BD - board
BIT - bituminous
BLDG - building
BLKG - blocking
BM - bench mark, beam(s)
BOT - bottom
BRZ - bronze
BS - both side
CB - catch basin
CEM - cement
CF - cubic foot
CFOI - contractor furnished owner installed
CG - corner guard
CH - ceiling height
CI - cast iron
CJ - control joint
CKBD - chalkboard
CL - centerline
CLG - ceiling
CLR - clear(ance)
CM - construction manager

CMT - ceramic mosaic (tile)
CMU - concrete masonry unit
COL - column
COM - communications
CONC - concrete
CONN - connect(ion)
CONST - construction
CONT - continuous or continue
CONTR - contract(or)
CPT - carpet
CRS - course(s)
CS - countersink
CSMT - casement
CT - ceramic tile
CTR - center
CVG - clear vertical grain
CW - cold water
CWT - ceramic wall tile
CY - cubic yard
D - depth
DEMO - demolish, demolition
DEP - depressed
DF - drinking fountain
DIA - diameter
DIAG - diagonal
DIM - dimension
DISP - dispenser
DIV - division
DL - dead load
DMT - demountable
DN - down
DP - dampproofing
DR - door
DS - Downspout
DT - drain tile
DTL - detail
DW - dumbwaiter
DWG - drawing(s)
DWR - drawer
EA - each
EB - expansion bolt
EF - each face
EJ - expansion joint
EL - elevation
ELEC - electric(al)
EMBED - embedment
EMER - emergency
ENCL - enclose(ure)
EP - electrical panel board
EQ - equal

EQUIP - equipment
EST - estimate
EVT - equiviscous temperature
EW - each way
EWC - electric water cooler
EX - existing
EXH - exhaust
EXP - exposed
EXT - exterior
FA - fire alarm
FAF - fluid applied flooring
FARF - fluid applied resilient floor
FAS - fasten, fastener
FBD - fiberboard
FBT - finished blowing temperature
FD - floor drain, fire damper
FE - fire extinguisher
FEC - fire extinguisher cabinet
FF - factory finish
FGL - fiberglass
FHMS - flathead machine screw
FHWS - flathead wood screw
FIN - finish(ed)
FLCO - floor cleanout
FLR - floor(ing)
FLUR - fluorescent
FND - foundation
FOC - face of concrete
FOIC - furnished by owner/installed by contractor
FOIO - furnished by owner/installed by owner
FOM - face of masonry
FP - fireproofing, flash point
FPHB - freeze-proof hose bib
FR - fire resistive, fire rated
FRM - frame(d), (ing)
FS - full size
FSS - finished structural slab
FT - foot
FTG - footing
FTS - finished topping slab
GA - gage, gauge
GALV - galvanized
GB - grab bar or gypsum board
GC - general contractor
GI - galvanized iron
GL - glass, glazing
GLS - glass resin wall surfacing
GP - gypsum
HB - hose bib
HBD - hardboard

HC - hollow core
HD - heavy duty
HDR - header
HDW - hardware
HM - hollow metal
HOR - horizontal
HP - high point
HR - hour
HT - height
HTG - heating
HVAC - heating, ventilating, air conditioning
HWD - hardwood
HWH - hot water heater
ID - inside diameter, identification
IN - inch
INCIN - incinerator
INCL - include(d), ion)
INT - interior
INV - invert
JB - junction box
JC - janitor's closet
JT - joint
KD - kiln dried
KCP - Keene's cement plaster
KO - knockout
KP - kick plate
LAB - laboratory
LAM - laminate(d)
LAV - lavatory
LBS - pounds
LH - left hand
LL - live load
LONGIT - longitudinal
LP - low point
LW - lightweight
MAX - maximum
MB - machine bolt
M. MECH - mechanic(al)
MFR - manufacture(r)
MH - manhole
MIN - minimum, minute
MISC - miscellaneous
MO - masonry opening
MO# - model number
MOD - modular
MPH - miles per hour
MS - machine screw
MTL - metal
MULL - mullion
MWP - membrane waterproofing

NAT - natural, natural finish
NIC - not in contract
NO - number
NOM - nominal
NTS - not to scale
OA - overall
OBS - obscure
OC - on center(s)
OD - outside diameter
OF - overflow
OFCI - owner furnished contractor installed
OFOI - owner furnished owner installed
OHMS - ovalhead machine screw
OHWS - ovalhead wood screw
OPG - opening
OPP - opposite
OZ - ounce(s)
P - paint(ed)
PB - push button
PCF - pounds per cubic foot
PCP - putting coat plaster
PERF - perforate(d)
PL - plate, property line
PLAM - plastic laminate
PLAS - plaster
PNL - panel
PP - push plate
PR - pair
PREP - prepare
PSF - pounds per square foot
PSI - pounds per square inch
PT - point, pressure treated
PTN - partition
PVC - polyvinyl chloride
PWD - plywood
QT - quarry tile
R - rise
RA - return air
RAD - radius
RCP - reflected ceiling plan
RD - roof drain
REF - reference
REFR - refrigerator
REINF - reinforce(ing)
REQ - required
RET'G - retaining
REV - revision(s), revised
RH - right hand
RM - room
RO - rough opening

RSF - resilient sheet flooring
SC - solid core
SCHED - schedule
SEC - section
SF - square feet (foot)
SHT - sheet
SHTHG - sheathing
SIM - similar
SL - sleeve
SOG - slab on grade
SPEC - specification(s)
SQ - square
SS - storm sewer
S4S - finished 4 sides
SD - storm drain
ST - steel, street
ST ST - stainless steel
STD - standard
STR - structural
SUPP - supplement
SUPT - support
SUSP - suspended
SV - sheet vinyl
T - tread
TBM - top bench mark
T&G - tongue and groove
TB - towel bar
TC - top of curb
TEL - telephone
TEMP - tempered
THK - thickness
TKBD - tackboard
TO - top of
TP - top of paving
TRANS - transverse
TS - top of slab
TV - television
TW - top of wall
TYP - typical
UNO - unless noted otherwise
VAT - vinyl asbestos tile
VB - vapor barrier
VCT - Vinyl Composition Tile
VERT - vertical
VG - vertical grain
VIF - verify in field
VWC - vinyl wall covering
W - width, wide, water
W/ - with
W/O - without

WC - water closet
WD - wood, wood finish
WP - waterproof(ing)
WNS - wainscot
WR - water resistant
WS - waterstop
WW - window wall
WWC - wood wall covering

1. WWF - woven wire fabric

1.02 WORDS WHICH MAY BE FOUND ELSEWHERE IN THE PROJECT MANUAL AND DRAWINGS ARE ABBREVIATED IN ACCORDANCE WITH THE STANDARDS SET FORTH IN THE FOLLOWING TABLE:

& - and
- angle
@ - at
- diameter, round
" - inches
: - is, shall b
' - feet
- perpendicular
/ - per
% - percent
- pound, number
X -by (as in 2 by 4)

END OF SECTION 01 4213

SECTION 01 4216
DEFINITIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Words which may be found elsewhere in the Contract Documents are defined in accordance with the standards set forth in the following table:

APPROVE:

Where used in conjunction with Architect's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be limited to the Architect's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect be interpreted as a release of Contract requirements.

AS DETAILED, AS SHOWN:

Where "as detailed", "as shown" or words of similar importance are used, it shall be understood that reference to the Drawings accompanying the Specifications is made unless otherwise stated.

AS DIRECTED, AS REQUIRED, AS AUTHORIZED, AS REVIEWED, AS ACCEPTED:

Where "as directed", "as required", "as authorized", "as reviewed", "as accepted" or words of similar importance are used, it shall be understood that the direction, requirement, permission, authorization, review, or acceptance of the Architect is intended, unless otherwise stated.

AS INDICATED:

Where "as indicated" is used it shall be understood that reference to Drawings and/or Specifications is made unless otherwise stated.

DIRECTED, REQUESTED, ETC.:

Terms such as "directed," "requested," "authorized," "selected," will be understood as "directed by Architect," "requested by Architect," and similar phrases shall not be interpreted to extend Architect's responsibility into Contractor's responsibility for construction supervision.

FURNISH:

Except as otherwise defined in greater detail the term "furnish" is used to mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

INDICATED:

The term "indicated" is a cross-reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the specifications and to similar means of recording requirements in Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for purpose of helping reader locate cross-reference and no limitation of location is intended except as specifically noted.

INSTALL:

Except as otherwise defined in greater detail, the term "install" is used to describe operations at project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

INSTALLER:

The term "installer" is defined as the entity (person or firm) engaged by Contractor, or its subcontractor or sub-subcontractor for performance of a particular unit of Work at project site, including installation, erection, application and similar required operations. It is a general requirement that such entities (Installers) be expert in operations they are engaged to perform.

PROVIDE:

Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

END OF SECTION 01 4216

SECTION 01 4219
REFERENCE STANDARDS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Quality Assurance.
- B. Location of References.
- C. Schedule of References.

1.02 QUALITY ASSURANCE**1.03 FOR PRODUCTS OR QUALITY OF WORK SPECIFIED BY ASSOCIATION, TRADE, OR FEDERAL STANDARDS, COMPLY WITH REQUIREMENTS OF THE STANDARD, EXCEPT WHEN MORE RIGID REQUIREMENTS ARE SPECIFIED OR ARE REQUIRED BY APPLICABLE CODES.**

- A. Conform to reference standard by date of issue current on date of Contract Documents.
- B. General Applicability of Standards: Except where Contract Documents include more stringent requirements, applicable standards of the construction industry have the same force and effect as if bound or copied directly into Contract Documents.
- C. Such standards are made a part of the Contract Documents by reference.
- D. Individual sections indicate which codes and standards the Contractor must keep at the project site, available for reference.
- E. Referenced industry standards take precedence over standards which are not referenced but recognized in industry as applicable.
- F. Non-referenced standards are not directly applicable to the Work, except as a general requirement of whether the Work complies with standards recognized in the construction industry.

1.04 LOCATION OF REFERENCES

- A. Valley Library, Oregon State University.

1.05 SCHEDULE OF REFERENCED ASSOCIATIONS

American Institute of Architects
WWW.AIA.ORG

American Institute of Steel Construction
WWW.AISC.ORG

American Iron and Steel Institute
WWW.STEEL.ORG

American National Standards Institute
WWW.ANSI.ORG

American Plywood Association
WWW.APAWOOD.ORG

American Society of Heating, Refrigerating, and
Air Conditioning Engineers
WWW.ASHRAE.ORG

American Society for Testing and Materials
WWW.ASTM.ORG

American Wood Protection Association
WWW.AWPA.COM

American Welding Society
WWW.AWS.ORG

Masonry Institute of America
WWW.MASONRYINSTITUTE.ORG

Oregon Bureau of Labor and Industries
WWW.BOLI.STATE.OR.US

Construction Contractors Board
WWW.OREGON.GOV.CCB/

Copper Development Association
WWW.COPPER.ORG

Cast Iron Soil Pipe Institute
WWW.CISPI.ORG

Construction Specification Institute
WWW.CSINET.ORG

Department of Environmental Quality (Oregon)
WWW.OREGON.GOV/DEQ/

Door and Hardware Institute
WWW.DHI.ORG

Department of Transportation
WWW.DOT.GOV

U.S. Environmental Protection Agency
WWW.EPA.GOV

Factory Mutual System
WWW.FMGLOBAL.COM

Federal Specification General Services Administration
Specifications and Consumer Information Distribution Section (WFSIS)
WWW.GSA.GOV/PORTAL/CONTENT/103856

International Building Code
WWW.ICCSAFE.ORG

International Conference of Building Officials
PUBLICCODES.CITATION.COM/ICOD/IBG/INDEX.HTM

Internal Revenue Service
WWW.IRS.GOV

Instrumentation Systems and Automation Society
WWW.ISA.ORG

National Association of Architectural Metal Manufacturers
WWW.NAAMM.ORG

National Board of Fire Underwriters
WWW.NFPA.ORG

National Electric Code
WWW.NECPLUS.ORG

National Electrical Manufacturers' Association
WWW.NEMA.ORG

National Electrical Safety Code
WWW.IEEE.ORG

National Fire Protection Association
WWW.NFPA.ORG

National Roofing Contractors' Association
WWW.NRCA.NET

Oregon Administrative Rules
ARCWEB.SOS.STATE.OR.US/404.HTML

State of Oregon Electrical Specialty Code
http://www.bcd.oregon.gov/programs/online_codes.html

Oregon Revised Statutes
LANDRU.LEG.STATE.OR.US/ORS/

Occupational Safety and Health Administration
WWW.OSHA.GOV

Oregon Structural Specialty Code
http://www.bcd.oregon.gov/programs/online_codes.html

- Product Standard
- A. STANDARDS.GOV/STANDARDS.CFM
 - B.

Steel Door Institute
WWW.STEELDOOR.ORG

Sheet Metal and Air Conditioning Contractors' National Association
WWW.SMACNA.ORG

Single Ply Roofing Institute
WWW.SPRI.ORG

Steel Structures Painting Council
WWW.SSPC.ORG

Sealing, Waterproofing and Restoration Institute
WWW.SWIRONLINE.ORG

Uniform Building Code (See ICBO)

Uniform Fire Code
WWW.NFPA.ORG

Underwriters' Laboratories, Inc.
WWW.UL.COM

Uniform Mechanical Code
WWW.UBC.COM

Uniform Plumbing Code
WWW.UBC.COM

Warnock Hersey Laboratories
WWW.INTEK.COM/MARKS/WH/

West Coast Lumber Inspection Bureau
WWW.WCLIB.ORG

Western Wood Products Association
WWW.WWPA.ORG

END OF SECTION 01 4219

SECTION 01 4500
QUALITY CONTROL

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Codes, regulations and permits.
- B. Procedures for quality control.

1.02 OWNER RESPONSIBILITIES

- A. Owner will employ and pay for services of an independent testing laboratory to perform inspection, sampling and testing as required by local building authority.
- B. Owner's Authorized Representative will provide on-site observation during construction.

1.03 CODES, REGULATIONS AND PERMITS

- A. All Work shall conform with the Oregon Structural Specialty Code (OSSC) based on the International Building Code (IBC), as amended by the State of Oregon Building Codes Division and the edition designated by the governing authority.
- B. Contractor shall comply with all applicable state and local construction codes.
- C. References to codes, Specifications and standards referred to in the Contract Documents shall mean, and are intended to be, the latest edition, amendment or revision of such reference standard in effect as of the date of these Contract Documents.
- D. The Owner shall be responsible for all permits and City of Corvallis plan review fees; the Contractor shall be responsible for all licenses and associated fees required for the Project.
- E. Contractor shall arrange and attend all required permit inspections and furnish evidence of approved City inspection reports per Section 01 77 00.

1.04 QUALITY OF WORK

- A. It is the true and specific intent of these Specifications that quality of Work on all phases of the construction and embracing all the trade sections shall be of high quality performed by workers skilled in their trade and performing their Work only according to the standard of best practice of the trade.
- B. All manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with manufacturer's directions unless otherwise specified.
- C. If Work is required in a manner to make it impossible to produce first quality Work, or should discrepancies appear among Contract Documents, request interpretation from Architect before proceeding with Work.
- D. Failure to secure interpretation may cause rejection by Architect or owner of installation.

1.05 LAYOUT

- A. Be responsible for properly laying out the Work and for lines and measurements for the Work.
- B. Verify the figures shown on the drawings before laying out the Work and report errors or inaccuracies to the Architect before commencing Work.
- C. Strict compliance with maximum slopes is required. Accessible parking spaces and adjacent access aisles with slope exceeding 2% in any direction, as determined by OSU, shall be removed and replaced by the contractor at their expense.
- D. Strict compliance with maximum slopes is required. New sidewalks exceeding 1:20 slope or with cross slope exceeding 2%, as determined by OSU, shall be removed and replaced by the contractor at their expense. Ramps exceeding 1:16 slope or with cross slope exceeding 2%, as determined by OSU, shall be removed and replaced by the contractor at their expense.

1.06 SUPERVISION

- A. The Contractor shall maintain effective supervision on the project at all times Work is being performed.
- B. The superintendent shall be the same person throughout the project and shall attend the preconstruction conference.

1.07 INSPECTIONS AND TESTING

- A. Contractor shall notify the Owner at least twenty-four (24) hours in advance of any required progress inspection or final inspection including final punch list inspection.
- B. Cooperate with laboratory personnel, provide access to Work and furnish incidental equipment material and labor required for field testing and sample taking.

1.08 EVALUATION OF TESTS AND INSPECTIONS

- A. Results of laboratory and/or field control tests and inspections shall be the principal basis upon which satisfactory completion of Work shall be judged.
- B. If results of tests and inspections indicate Work is below requirements of Contract Documents, that portion of Work is subject to rejection.

1.09 ADJUSTMENTS

- A. Remove and replace Work so rejected at Contractor's expense including costs of subsequent tests and inspections until Work meets requirements of Contract Documents.
- B. The Owner reserves the right to perform any testing as may be required to determine compliance with the Contract Documents.
- C. Costs for such testing will be the Owner's responsibility unless testing indicates noncompliance. Cost for such testing indicating noncompliance shall be borne by the Contractor.
- D. Noncomplying Work shall be corrected and testing will be repeated until the Work complies with the Contract Documents.
- E. Contractor will pay costs for retesting noncomplying Work.

END OF SECTION 01 4500

SECTION 01 5100
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. This Section specifies requirements for temporary services and facilities, including utilities, construction and support facilities, security and protection.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

- A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction.
- B. Standards: Comply with NFPA Code 241, "Building Construction and Demolition Operations", ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition".
- C. Electrical Service: Comply with NEMA, NEC and UL standards and regulations for temporary electric service; install service in compliance with National Electric Code (NFPA 70).
- D. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use; obtain required certifications and permits if required.

1.03 PROTECTION

- A. Protect sidewalks, asphalt paving, concrete, trees, shrubs, and lawn areas at all times from damage resulting from construction activities.
- B. Prevent materials from clogging catch basins and yard drains; leave drains clean and in proper working condition.
- C. Protect Existing Irrigation Systems:
 - 1. In the event damage occurs to an underground irrigation system as a direct result of a Contractor's activities, the Contractor shall repair/replace or be assessed a charge at the discretion of the Owner.
 - 2. If repairs are to be made by the Contractor, the repairs will be inspected by the Owner's Authorized Representative prior to backfilling.
 - 3. Any galvanized pipe that requires repair shall be repaired at a threaded coupling, not by use of a compression coupling.
- D. Protect Existing Air Handling Systems:
 - 1. Contractor shall be responsible for protection of the cleanliness of the existing air handling system at all times. This protection shall include:
 - a. During site work or building demolition, prefilters shall be provided and maintained on all building outside air intakes at all times throughout the construction duration.
 - b. During any interior work that may create dust in the interior space and adjacent corridor/hallways, air filters shall be provided and maintained on all affected air return and exhaust grilles. Where air flow in or out of the space is not required, all air duct openings shall be temporarily blanked off with plywood or sheet metal.
 - c. Prior to starting any work, the Contractor shall record and submit to the Owner's Authorized Representative, pressure readings across all existing air handler air filter banks before installation of new prefilters.
 - d. Upon completion of all Work affecting existing air handling systems, the Contractor shall remove all temporary filters, covers and associated parts and restore the system to its original operating condition unless otherwise stated elsewhere in the Contract Documents

- E. Clean, repair, resurface, or restore existing surfaces to their original, or better, condition, or completely replace such surfaces to match existing, where damaged by construction operations.
- F. Security is the responsibility of the Contractor.
- G. Construction Debris:
 - 1. Debris shall not be allowed to remain around the buildings during performance of Work, but shall be disposed of as rapidly as it accumulates.
 - 2. On completion of Work, the buildings and grounds shall be left in a condition that is equal to or better than original condition.
 - 3. In case of failure to do so, the Owner may remove rubbish and charge the cost to the Contractor.
- H. The Contractor shall manage a safe job environment for both the safety of all the people around the Work site as well as the safety of the Owner's and general public's property.
- I. The Contractor shall provide and maintain suitable barricades, shelters, lights, and danger signals during the progress of the Work; they shall meet the requirements of the local building code and OSHA.

1.04 DRAINAGE

- A. Verify that all rain drains in the construction areas are in working order and notify the Owner's Authorized Representative in writing of any rain drains that are plugged, prior to the start of the Work.
- B. Start of Work will be considered as acknowledgment that all drains are clear and in good working order.
- C. All drains shall be left in a clean and proper working condition.

1.05 CONSTRUCTION PROJECT SAFETY FORM

- A. Contractor shall submit to the Owner, prior to signing the Contract, the completed "Construction Project Safety Form", which is provided with instructions at the end of this Section.

1.06 TEMPORARY UTILITIES

- A. Temporary Utilities:
 - 1. Prepare a schedule indicating dates for implementation and termination of each temporary utility.
 - 2. At the earliest feasible time, when acceptable to the Owner, change over from use of temporary service to use of the permanent service.
- B. Conditions of Use:
 - 1. Keep temporary services and facilities clean and neat in appearance.
 - 2. Operate in a safe and efficient manner.
 - 3. Take necessary fire prevention measures.
 - 4. Do not overload facilities or permit them to interfere with progress.
 - 5. Do not allow hazardous, dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.
- C. Electrical Service:
 - 1. Service limited to 20 amp 120V circuits will be paid for by the Owner.
 - 2. Connection to the service shall be the responsibility of the Contractor, with the Owner's approval.
 - 3. Coordinate with the Owner's Authorized Representative.
- D. Water Service:
 - 1. Service in reasonable quantities for the Project will be paid for by the Owner.
 - 2. Connection to the service shall be the responsibility of the Contractor, with the Owner's approval.

3. Coordinate with the Owner's Authorized Representative.

1.07 TEMPORARY SUPPORT FACILITIES

- A. Temporary Sanitary Facilities:
 1. Provide and maintain an adequate number of facilities for the use of all persons employed on the Work during construction.
 2. Provide enclosed, weatherproof facilities with heat as required.
 3. Use of new or existing Owner's facilities will not be permitted.
- B. Temporary Heat and Ventilation:
 1. As necessary, provide temporary heat and ventilation required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.
- C. Telephone Equipment: Provide telephone communications at project site.
- D. Existing Services:
 1. Do not interrupt any existing service.
 2. Prior request and approval of the Owner's Representative will enable the Owner to shut down any utility required by the Work.
 3. Contractor shall not shut down utilities.

1.08 TEMPORARY BARRIERS AND ENCLOSURES

- A. Provide barriers and fencing to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage.
- B. Provide Commercial grade chain link fence construction.
- C. Provide 6 foot high fence around construction site as directed by Owner's Authorized Representative; equip with vehicular and pedestrian gates with lock.
- D. Exterior Closures: Provide temporary secured, weather-tight closures at exterior openings, to permit acceptable working conditions and protection of the Work.
- E. Interior Closures:
 1. Provide temporary floor to ceiling partitions (not plastic sheeting) and ceilings as required to separate work areas from Owner occupied areas, to prevent penetration of dust and moisture into Owner occupied areas, to reduce construction noise, and to prevent damage to existing materials and equipment.
 2. Paint surfaces exposed to view from Owner occupied areas.

1.09 ODORS

- A. Work that causes excessive odors shall be performed only after coordination with the Owner's Authorized Representative. Filtering of air intakes to units may be required to prevent odors and vapors from entering the buildings.
- B. Contractor shall provide 7 days advance notice to the Owner's Authorized Representative in order for advance notice to be forwarded to building occupants. Work stoppage may occur if advance notification has not been coordinated or odors and vapors from the work are found to generate complaints from building occupants.

1.10 FIRE SAFETY

- A. Ensure that required exit routes remain unobstructed while building is occupied.
- B. Abide by all fire safety requirements for buildings under construction, alteration or demolition as required by Article 87, of the Uniform Fire Code as adopted by the State of Oregon.
- C. An emergency telephone shall be provided on site. Cellular telephone equipment is acceptable.

- D. Fire Suppression Equipment:
1. Install and maintain temporary fire protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers", and NFPA 241 "Standard for Safeguarding Construction, Alterations and Demolition Operations".
 2. Maintain equipment in working condition with current inspection certificate attached to each.
 3. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near each usable stairwell.
 4. Store combustible materials in containers in fire-safe locations.
 5. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways, and other access routes for fighting fires.
 6. Provide continual supervision of welding operations, combustion type temporary heating units, and similar sources of fire ignition.
 7. When possible, relocate hot work to a designated hot work area.
 8. If the materials or equipment cannot be relocated to a designated hot work area, use the least hazardous form of hot work that will get the job done and prepare the area properly.
 9. Manage mobile hot work using the formal hot work permit system. (mentioned in the next bullet point and also a directive in the OSU Hot Work Safety Program)
 10. Make sure both fire protection and hot work equipment work properly.
 11. Train all personnel involved in hot work operations and activities so that they have the understanding, knowledge, and skills necessary to safely perform their jobs.

1.11 CONSTRUCTION AIDS

- A. Scaffolding: comply with applicable OSHA requirements.
- B. Material Handling Equipment:
1. Provide necessary cranes, hoists, towers, or other lifting devices.
 2. Use only experienced operators.
 3. Remove equipment as soon as possible after task is ended.
 4. Coordinate placement of such equipment with Owner's Authorized Representative.
 5. Obtain required permits and meet requirement of governing authorities regarding applicable regulations.
- C. Materials or debris shall not be allowed to free fall from building.
- D. The use of chutes or conveyors must be approved by Owner.

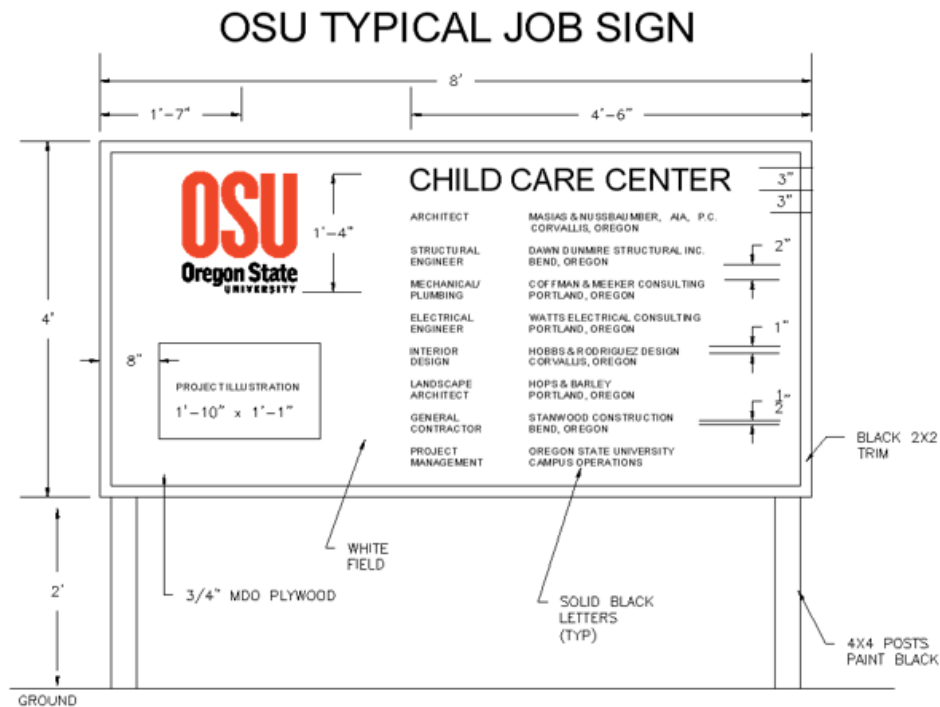
1.12 TEMPORARY CONTROLS

- A. Water Control:
1. Maintain excavations free of water.
 2. Provide, operate, and maintain necessary pumping equipment.
- B. Protection:
1. Protect installed Work and provide special protection where specified in individual specification sections.
 2. Prohibit traffic or storage upon waterproofed or roofed surfaces.
- C. Security:
1. Provide security and facilities to protect Work and existing facilities and Owner's operations from unauthorized entry, vandalism, or theft.
 2. Coordinate operations with Owner's Authorized Representative.
- D. Temporary Traffic Control /Pedestrian Accessibility
1. A continuous route for all pedestrians, including persons with disabilities and bicyclists, shall be maintained at all times. When existing pedestrian facilities are disrupted, closed, or relocated in a construction zone, temporary pedestrian facilities shall be provided.

2. Temporary pedestrian facilities should be safe and accessible. There should be no curbs or abrupt changes in grade that could cause tripping or be a barrier to wheelchair use.
3. Signage shall be provided directing people to the temporary accessible route. The signage shall include the International Symbol of Accessibility.
4. Contractors shall not block temporary walkways with vehicles, equipment, construction materials, signs, trash, or other objects that might prohibit pedestrian passage.
5. Construction equipment and equipment operation must be separated from any open walkways. At construction zones, pedestrian fences or other protective barriers shall be provided to prevent access into the construction zone.

1.13 PROJECT SIGNAGE

- A. Contractor is permitted to post only one project identification sign based on the following example:



1.14 PREPARATION

- A. Consult with Owner to review jobsite areas required for field offices, material storage and stockpiles, equipment storage, access to different locations, etc.

1.15 PERFORMANCE

- A. Confine equipment, apparatus, and storage of material to work limits. The Owner will not be responsible for protection of materials and equipment from damage, pilfering, etc.
- B. Install temporary facilities in such a manner that the installed work will not be damaged.
- C. Do not use facilities of existing building unless authorized in writing by the Owner.
- D. Effective September 1, 2012, OSU became a non-smoking campus and smoking is prohibited on all Campus property.
- E. Keep facilities well maintained.
- F. Relocate temporary facilities as required during job progress.
- G. At Substantial Completion, clean and renovate permanent facilities that have been used during the construction period, including but not limited to:

1. Replace air filters and clean inside of ductwork and housings.
2. Replace significantly worn parts and parts that have been subject to unusual operating conditions.
3. Replace lamps that are burned out or noticeably dimmed by substantial hours of use.

END OF SECTION**OREGON STATE UNIVERSITY CONSTRUCTION AND MAINTENANCE SAFETY REQUIREMENTS****EH&S, 130 OAK CREEK BUILDING, CORVALLIS, OR 97331-7405, (541) 737-2505,****FAX (541) 737-9090****COMPLETE OSU CONSTRUCTION AND MAINTENANCE SAFETY FORM - SEND COMPLETED DOCUMENTS (INCLUDING SITE SAFETY PLAN AND ALL SEPARATE ANSWER PAGES) TO CONSTRUCTION CONTRACT ADMINISTRATION ALONG WITH THE SIGNED CONTRACT AND BONDS.****PROJECT ISOLATION - ALL CONSTRUCTION AND REMODELING ACTIVITIES REGARDLESS OF SIZE AND/OR SCOPE MUST BE FENCED, BARRICADED, OR OTHERWISE PROTECTED TO RESTRICT ENTRANCE AND TO ENSURE THE SAFETY OF THOSE IN THE GENERAL AREA. SEE ISOLATION REQUIREMENTS.****SITE SAFETY PLAN - A SITE SAFETY PLAN WILL BE REQUIRED AND WILL ADDRESS:**

General Information
Emergency Information
Key Organization Personnel
Hazard Evaluation/Facility Impact
Emergency Procedures
Work Zones
Security Measures
Fire Protection

A MODEL PLAN IS ATTACHED. THIS FORM CAN BE USED IF ANOTHER PLAN HAS NOT ALREADY BEEN PREPARED. CONTACT OSU ENVIRONMENTAL HEALTH & SAFETY FOR MORE INFORMATION 737-2505.**ISOLATION REQUIREMENTS**

General: All construction, maintenance, and remodeling activities, regardless of size or scope, must be fenced, barricaded, or otherwise isolated to restrict entrance and to ensure the safety of those in the general area.

Outdoor Activities: Outdoor projects require the following perimeter isolation:

1. A six foot chain-link fence, with controlled access points, extending in all directions around the excavation or building site such that no area of the construction is accessible to pedestrians or unauthorized personnel or vehicles.
2. Isolation area will include vehicle loading and unloading areas.
3. At the University's option, other barricading plans may be accepted. These may apply to projects such as road resurfacing, parking lot striping, exterior building water proofing, deliveries, etc. Contact EH&S regarding other barricading plans.

Overnight: Any excavation across or adjacent to sidewalks or pathways which must be left open overnight, must be identified with working, blinking construction lights in addition to solid barricades

Indoor Activities: Indoor construction or maintenance projects which will create dust, potentially hazardous fumes or vapors, or offensive odors are subject to the following isolation:

4. Areas where existing doors can provide isolation will be labeled "Construction Area-- Authorized Personnel Only ".
5. All other areas will be isolated by a solid barrier. The minimum barrier allowed is 4 mil poly sheeting sealed to prevent migration of dust.
6. Mechanical ventilation may be required.
7. A solid wall is required if building envelope is opened to the outside.

Contractor Responsibilities

8. The contractor will provide all barricading, isolation, and fencing material. OSU will not provide any materials.
9. The contractor will also provide all appropriate warning and detour signs when sidewalks, exits, or roads are closed.
10. Contractor will provide all other construction area signs.

OSU CONSTRUCTION AND MAINTENANCE SAFETY FORM

SEND COMPLETED SAFETY DOCUMENTS TO CONSTRUCTION CONTRACT ADMINISTRATION WITH CONTRACT AND BONDS.

DATE:

PROJECT:

START DATE:

COMPLETION DATE:

CONTRACTOR:

CONTACT:

WORK #:

24 HR #:

OSU PROJECT MGR:

WORK / 24HR #'S:

DEPT. CONTACT:

OSU EH&S CONTACT:

PRECONSTRUCTION MEETING? Y N DATE/TIME/LOCATION:

FOR THE FOLLOWING ITEMS, PREPARE ANSWERS ON A SEPARATE SHEET FOR ALL ITEMS MARKED "YES". PRECEDE EACH ANSWER WITH THE APPROPRIATE ITEM NUMBER. ALL BOXES NEED TO BE CHECKED

Y	N		FOR THIS PROJECT	IF YES, THEN:
		1	WILL ANY CONFINED SPACES BE ACCESSED?	DESCRIBE LOCATION OF ENTRY SPECIFY LOCATION OF PERMIT NOTIFY EH&S PRIOR TO ENTRY SEE SAF 209
		2	WILL HOT WORK BE PERFORMED (WELDING, CUTTING, BRAZING, ETC.)?	PROVIDE MIN. 5# 2A10BC EXTINGUISHER WITHIN 10 FT IF INDOORS - PROVIDE AND DESCRIBE VENTILATION SEE SAF 214
		3	ANY PRODUCTS BROUGHT TO CAMPUS?	PROVIDE MSDS ON SITE PRIOR TO FIRST USE; MAKE AVAILABLE TO OSU ON REQUEST
		4	WILL LEAD PAINT BE IMPACTED?	DESCRIBE PLAN TO LIMIT CONTAMINATION

	5	WILL ASBESTOS-CONTAINING-MATERIAL BE IMPACTED?	COORDINATE WITH OSU ASBESTOS MANAGER
	6	WILL ANY MATERIALS (CONSTRUCTION DEBRIS, SOIL, WATER, ETC) BE REMOVED FROM CAMPUS?	DESCRIBE IN DETAIL IDENTITY AND DISPOSITION OF MATERIAL (HOW, WHERE)
	7	ANY OPEN TRENCHES OR HOLES?	DESCRIBE ISOLATION PROCEDURES (SEE PAGE 1)
	8	WILL A CRANE BE USED?	DESCRIBE CRANE SAFETY PLAN (INCLUDE PLAN TO PREVENT LOADS ABOVE OCCUPIED AREAS)
	9	IS THIS PROJECT BUILDING A NEW FACILITY, A MAJOR REMODEL?	PROVIDE SITE SAFETY PLAN DESCRIBE ISOLATION PROCEDURES (SEE PAGE 1)
	10	IS THIS A MINOR REMODELING PROJECT?	PROVIDE, OR FILL OUT MODEL SITE SAFETY PLAN FORM (SEE PAGE 3) DESCRIBE ISOLATION PROCEDURES (SEE PAGE 1)
	11	WILL AIR CONTAMINATION BE PRODUCED (E.G. DUST, CO, SOLVENT VAPORS, VOCS, ODORS)?	DESCRIBE PROJECT VENTILATION AND ISOLATION INDICATE POSITION OF BUILDING AIR INTAKE(S)
	12	WILL THERE BE NOISE > 85 DB?	DESCRIBE NOISE MINIMIZATION PLAN
	13	WILL THIS PROJECT USE A SCAFFOLD OR AN EXTERNAL CHUTE?	DESCRIBE ISOLATION, DUST CONTROL, INSTALLATION
	14	WILL THIS PROJECT INVOLVE A WORKING SURFACE >6' ABOVE A LOWER LEVEL	DESCRIBE FALL PROTECTION
	15	WILL ANY "BLIND" SAW-CUTS OR PENETRATIONS BE MADE IN EXISTING FOUNDATIONS, FLOORS, CEILINGS AND/OR WALLS?	DESCRIBE PLAN FOR DETECTING AND PROTECTING POWER LINES OR OTHER BUILDING UTILITY LINES.

DATE:

MODEL SITE SAFETY PLAN

GENERAL INFORMATION

CONTRACTOR NAME:

ADDRESS:

CITY, STATE, ZIP:

SITE SAFETY OFFICER:

PROJECT DATES

PROJECT NAME

EMERGENCY INFORMATION

EMERGENCY RESPONSE	911	OSU EH&S AND OSU FACILITIES SERVICES MUST BE NOTIFIED IN THE EVENT OF AN EMERGENCY
HAZARDOUS MATERIALS SPILL		
MSDS ON-SITE LOCATION		
OSU EH&S	(541) 737-2505	
FACILITIES SERVICES	(541) 737-2969	

CONTRACTOR KEY PERSONNEL

	NAME	PHONE	EMERGENCY CONTACT
COMPANY OWNER			
PROJECT MANAGER			
JOB SUPERVISOR			
SITE SAFETY OFFICER			
OTHER RESPONSIBLE INDIVIDUAL			
24 HOUR NOTIFICATION			

LIST OF EMPLOYEES ON SITE

4. HAZARD EVALUATION/ FACILITY IMPACT		5. EMERGENCIES	
	YES / NO	SERVICES	
PHYSICAL			
HEAVY EQUIPMENT			
NOISE		EVACUATION ROUTE	
HEAT			

ELEVATION			FIRST AID LOCATION	
RADIATION MATERIALS				
EXCAVATIONS			HAZARDOUS MATERIALS SPILL PROCEDURE	
UNDERGROUND UTILITIES				
CONFINED SPACES				
FIRE PREVENTION				
ELECTRICAL				

WORK ZONES

MATERIAL STORAGE:

PARKING LOCATIONS:

INDIVIDUALS WITH OSU KEYS:

ACCESS ISSUES:

SECURITY MEASURES:

FIRE PROTECTION:

SECTION 01 5639
TREE AND PLANTING PROTECTION

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Section includes temporary fencing, barricades, and guards to protect trees, plants and groundcovers not indicated to be removed, as necessary and required to prevent damage above and below grade.

1.02 DEFINITIONS

- A. Dripline: Outer perimeter of branches of any tree or plant.
- B. Groundcover: Includes but not limited to plants and grass.

1.03 PERFORMANCE REQUIREMENTS

- A. The Contractor shall exercise utmost care to protect existing trees and plants designated to remain and shall comply with all protection requirements provided by Owner and City of Corvallis as conveyed through the Owner's Authorized Representative.
- B. The Contractor shall install tree protection fencing as detailed and shall prevent damage to shrubs, groundcover, trees, root systems, soil, bark, foliage, branches and limbs due to construction activities, including but not limited to:
 - 1. Soil contamination, erosion, and compaction.
 - 2. Excessive wetting, and ponding due to storm water, and construction run-off.
 - 3. Alteration of grade, stockpiling of soil, debris, and materials.
 - 4. Damage to soil, roots, bark, trunk, limbs, branches, and foliage.
 - 5. Prevent unauthorized cutting, breaking, skinning and bruising of roots, branches, and bark.

1.04 SUBMITTALS

- A. Procedural proposal for tree and plant protection, describe methods of protection, and stabilization, provide drawings and supporting documentation as directed.
- B. Contractor's Condition Inspection; include written report and color photographs.

1.05 PROJECT CONDITIONS

- A. Install protection during initial mobilization at the Work site, and maintain until substantial completion.
- B. If, in the opinion of the Owner's arborist, additional protection is required, the Contractor shall install additional fencing as directed and without cost to the Owner.
- C. The location and requirements for additional fencing shall be determined by the Owner's arborist prior to, and at any time during the course of the Work.
- D. Fencing:
 - 1. Fencing shall be installed at the tree and plant protection areas as detailed on Plans, or as directed by the Owner's Authorized Representative.
 - 2. Tree and plant protection fences shall remain in place until all Work is completed and shall not be removed or relocated without the approval of the Owner's Authorized Representative.
- E. Driving and Parking:
 - 1. Not permitted off paved surfaces without the approval of the Owner's Authorized Representative.
 - 2. When approved, the Contractor shall place plywood of sufficient thickness and width to support vehicles and prevent rutting on the area to be driven on.
 - 3. Care shall also be taken with respect to existing lawn sprinkler systems.

- F. Storage of materials and Debris: Not permitted off paved surfaces.

PART 2 PRODUCTS

2.01 MANUFACTURED COMPONENTS

- A. Chain Link Fencing: 11 gage galvanized chain link, six feet. tall, and 1.5 inch inside diameter galvanized steel line posts and 2.5 inch inside diameter corner posts, provide lockable gates as necessary.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Inspect trees, plants, and groundcovers, document existing conditions prior to installation of protection.

3.02 EXECUTION

- A. Pruning and Cutting of Roots, Branches and Foliage:
1. Review conditions with Architect or Owner prior to need for work, and proceed as directed.
 2. All pruning to be done by Owner's landscape maintenance personnel or ISA Certified arborist under the direction of Owner's Landscape Management Department.
 3. Perform pruning and cutting with sharp instruments intended for the purpose; do not break or chop.
- B. Root Cuttings:
1. Carefully and cleanly cut roots and branches of trees indicated to be left standing where such roots and branches obstruct new construction.
 2. Protect exposed roots with wet burlap until they can be covered with soil.
- C. Excavation and Trenching Within Drip Lines:
1. Permitted where indicated, and at other specifically approved locations.
 2. Tunnel under or around roots by hand digging or boring.
 3. Do not cut main lateral roots and tap roots over one inch diameter; cut smaller roots which interfere with installation of new Work.
 4. Do not allow exposed roots to dry out before permanent backfill is placed; provide temporary earth cover, or pack with peat moss and wrap with burlap.
 5. Water and maintain roots in moist condition and temporarily support and protect from damage until permanently relocated and covered with backfill.
- D. Existing Grading: Maintain within drip line of trees and plants unless otherwise indicated on the drawing and approved by the Owner's Authorized Representative.
- E. Tree Protection:
1. Provide temporary fence complying with Section 01 51 00 for protection of trees to remain.
 2. Extend fencing ten feet beyond dripline, except where greater distance is required for protection of Elm trees.
 3. Prevent entry into protected areas except as authorized in writing by the Owner's Authorized Representative.

3.03 REPAIR AND REPLACEMENT OF TREES AND PLANTS

- A. Repair trees or shrubs damaged by construction operations as directed by the Owner.
- B. Make repairs promptly after damage occurs to prevent progressive deterioration of damaged trees.
- C. Damaged Trees, Shrubs and Groundcover:
1. Replace where Owner's Authorized Representative determines restoration to normal growth pattern is not possible; plant and maintain as directed.
 2. Replacement trees up to 13 inches caliper and shrubs up to 4 feet tall: Same size as damaged tree or shrub, species selected by the Owner's Authorized Representative.

3. Trees over 13 inch caliper and shrubs greater than 4 feet tall: Compensate Owner as determined by an acceptable consulting arborist registered with the American Society of Consulting Arborists.
4. Replacement groundcovers: Same size and quality as damaged species selected by Owner's Authorized Representative.

END OF SECTION 01 5639

SECTION 01 6000
PRODUCT REQUIREMENTS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Summary:
 - 1. Product options.
 - 2. Owner-furnished products.
 - 3. Product delivery, storage and handling.

1.02 PRODUCTS

- A. Products:
 - 1. New material, machinery, components, equipment, fixtures, and systems forming the Work, but does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work.
 - 2. Products may also include existing materials or components specifically identified for reuse.
- B. Use interchangeable components of the same manufacture for similar components.
- C. Unless otherwise specified, all material and equipment shall be new; free from defects impairing strength, durability, and appearance; of current manufacture.
- D. Items specified shall be considered minimum as to quality, function, capacity, and suitability for application intended.
- E. Items incorporated into the Work shall conform to applicable specifications and standards designated, and shall be of size, make, type, and quality specified.
- F. Design, fabricate, and assemble in accordance with current best engineering, industry, and shop practices.
- G. Manufacture like parts of duplicate units to standard size and gauge to make them interchangeable.
- H. Two or more items of the same kind shall be identical and made by the same manufacturer.

1.03 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.
- C. Products Specified by Naming One [or More] Manufacturer[s]: Products of manufacturer[s] named and meeting specifications, no options or substitutions allowed.
- D. Substitution Procedure: Under Section 01 25 00.

1.04 REUSE OF EXISTING PRODUCTS

- A. Except as specifically indicated or specified, materials and equipment removed from existing construction shall not be used in the completed Work.
- B. For material and equipment specifically indicated or specified to be reused in the Work:
 - 1. Use care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
 - 2. Arrange for transportation, storage, and handling of products which require off-site storage, restoration, or renovation.
 - 3. Remove and reinstall mechanical units, vents, guys, antennae, and electrical and grounding wires or conduits.

1.05 OWNER FURNISHED PRODUCTS

- A. Designate delivery dates of Owner-furnished items in the construction schedule.
- B. Receive, unload, store and handle Owner-furnished items at the site; protect from damage.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Transport, handle, store and protect products in accordance with manufacturer's instructions.
- B. Arrange deliveries in accordance with construction schedules; coordinate to avoid conflict with Work and site conditions.
- C. Deliver and store products in undamaged condition in manufacturer's original containers or packaging with identifying labels intact and legible.
- D. Inspect shipments to assure compliance with Contract Documents and reviewed submittals, and that products are undamaged.
- E. Prevent soiling or damage to products or packaging.
- F. Interior Storage: Maintain required temperature and humidity ranges. Verify that Owner furnished storage meets product manufacturer's requirements.
- G. Exterior Storage:
 - 1. Store materials above ground to prevent soiling and/or moisture infiltration.
 - 2. Cover materials with waterproof breathable sheet coverings; provide adequate ventilation.
 - 3. All storage locations to be approved in advance by the Owner.
- H. Arrange storage to provide access for inspection.
- I. Coordinate with Owner's Authorized Representative all on-site storage activities.
- J. Provide for security of stored products.

END OF SECTION 01 6000

SECTION 01 6116
VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. VOC restrictions for product categories listed below under "DEFINITIONS."
- B. All products of each category that are installed in the project must comply; Owner's project goals do not allow for partial compliance.

1.02 RELATED REQUIREMENTS

- A. Section 01 3000 - Administrative Requirements: Submittal procedures.
- B. Section 01 4000 - Quality Requirements: Procedures for testing and certifications.
- C. Section 01 6000 - Product Requirements: Fundamental product requirements, substitutions and product options, delivery, storage, and handling.

1.03 DEFINITIONS

- A. VOC-Content-Restricted Products: All products in the following categories when installed or applied on-site in the building interior:
 - 1. Adhesives, sealants, and sealer coatings.
 - 2. Carpet.
 - 3. Carpet tile.
 - 4. Resilient floor coverings.
 - 5. Paints and coatings.
 - 6. Insulation.
 - 7. Gypsum board.
 - 8. Acoustical ceilings and panels.
 - 9. Cabinet work.
 - 10. Wall coverings.
 - 11. Composite wood and agrifiber products used either alone or as part of another product.
 - 12. Other products when specifically stated in the specifications.
- B. Interior of Building: Anywhere inside the exterior weather barrier.
- C. Adhesives: All gunnable, trowelable, liquid-applied, and aerosol adhesives, whether specified or not; including flooring adhesives, resilient base adhesives, and pipe jointing adhesives.
- D. Sealants: All gunnable, trowelable, and liquid-applied joint sealants and sealant primers, whether specified or not; including firestopping sealants and duct joint sealers.

1.04 REFERENCE STANDARDS

- A. CRI (GLP) - Green Label Plus Testing Program - Certified Products; www.carpet-rug.org; current edition.
- B. GreenSeal GC-03 - Anti-Corrosive Paints; Green Seal, Inc.; 2007
- C. GreenSeal GS-11 - Paints; Green Seal, Inc.; 1993.
- D. GreenSeal GS-36 - Standard for Adhesives for Commercial Use; 2013.
- E. SCAQMD 1113 - Architectural Coatings; 1977, with Amendment (2016).
- F. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2017).
- G. SCS (CPD) - SCS Certified Products; Current Edition.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Evidence of Compliance: Submit for each different product in each applicable category.

- C. Product Data: For each VOC-restricted product used in the project, submit evidence of compliance.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All Products: Comply with the most stringent of federal, State, and local requirements, or these specifications.
- B. Adhesives and Joint Sealants: Provide only products having volatile organic compound (VOC) content not greater than required by South Coast Air Quality Management District Rule No.1168.
1. Definition: This provision applies to gunnable, trowelable, and liquid-applied adhesives, sealants, and sealant primers used anywhere on the interior of the building inside the weather barrier, including duct sealers and fire stopping.
 2. Certification: Require each installer to certify compliance and submit product data showing product content.
 - a. Evidence of Compliance: Acceptable types of evidence are:
 - 1) Report of laboratory testing performed in accordance with requirements.
 - 2) Published product data showing compliance with requirements.
 - 3) Certification by manufacturer that product complies with requirements.
 3. SCAQMD limits for specific product categories:
 - a. Architectural Applications VOC Limit g/L less water
 - 1) Indoor Carpet Adhesives 50
 - 2) Wood Flooring Adhesive 100
 - 3) Rubber Floor Adhesives 60
 - 4) Subfloor Adhesives 50
 - 5) Ceramic Tile Adhesives 65
 - 6) Dry Wall and Panel Adhesives 50
 - 7) Cove Base Adhesives 50
 - 8) Multipurpose Construction Adhesives 70
 - 9) Structural Glazing Adhesives 100
 - b. Specialty Applications VOC Limits g/L less water
 - 1) PVC Welding 510
 - 2) CPVC Welding 490
 - 3) ABS Welding 325
 - 4) Plastic Cement Welding 250
 - 5) Adhesive Primer for Plastic 550
 - 6) Computer Diskette Manufacturing 350
 - 7) Contact Adhesive 80
 - 8) Special Purpose Contact Adhesive 250
 - 9) Top and Trim Adhesive 250
 - c. Substrate Specific Applications VOC Limit g/L less water
 - 1) Metal to Metal 30
 - 2) Plastic Foams 50
 - 3) Porous Material (except wood) 50
 - 4) Wood 30
 - 5) Fiberglass 80
 - d. Sealants VOC Limit g/L less water
 - 1) Architectural 250
 - 2) Other 420
 - e. Sealant Primers VOC Limit g/L less water

- 1) Architectural Non Porous 250
 - 2) Architectural Porous 775
 - 3) Other 750
- C. Aerosol Adhesives: Provide only products having volatile organic compound (VOC) content not greater than required by GreenSeal GS-36.
1. Certification: Require each installer to certify compliance and submit product data showing product content.
 - a. Evidence of Compliance: Acceptable types of evidence are:
 - 1) Current GreenSeal Certification.
 - 2) Report of laboratory testing performed in accordance with GreenSeal GS-36 requirements.
 - 3) Published product data showing compliance with requirements.
 2. GreenSeal limits for specific product categories:
 - a. Aerosol Adhesives VOC Weight g/L minus water
 - 1) General purpose mist spray 65% VOCs by weight
 - 2) General purpose web spray 55% VOCs by weight
 - 3) Special purpose aerosol adhesives (all types) 70% VOCs by weight
- D. Paints and Coatings:
1. Definition: This provision applies to paints and coatings used anywhere on the interior of the building inside the weather barrier, including all primers and sealers.
 2. Provide coatings that comply with the most stringent requirements specified in the following:
 - a. Architectural Paints and Coatings: Do not exceed VOC content limits established in GreenSeal GS-11.
 - b. Anti-Corrosive and Anti-Rust Paints: Do not exceed VOC content limits established in GreenSeal GS-03.
 - c. Clear Wood Finishes, Floor Coatings, Stains, Primers and Shellacs: Do not exceed the VOC content limits established in SCAQMD Rule No. 1113.
 3. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
 4. Certification: Require each installer to certify compliance and submit product data showing product content.
 - a. Evidence of Compliance: Acceptable types of evidence are:
 - 1) Report of laboratory testing performed in accordance with requirements.
 - 2) Published product data showing compliance with requirements.
 5. Limits for specific product categories:
 - a. Architectural paints, coatings and primers applied to interior walls and ceilings per GreenSeal GS-11
 - 1) Flats: 50 g/L
 - 2) Non-Flats: 150 g/L
 - 3) Primers 50 g/L
 - b. Interior Anti-Corrosive and Anti-rust paints, coatings and primers per GreenSeal GS-03, Anti-Corrosive Paints
 - 1) 250 g/L
 - c. All other coatings, paints and sealers per SCAQMD Rule #1113, Architectural Coatings
 - 1) Coating Category VOC Limit g/L
 - (a) Bond Breakers 350
 - (b) Clear Wood Finishes 275
 - (c) Varnish 275

- (d) Sanding Sealers 275
 - (e) Lacquer 275
 - (f) Clear Brushing Lacquer 275
 - (g) Concrete-Curing Compounds 100
 - (h) Dry-Fog Coatings 150
 - (i) Flats 50
 - (j) Floor Coatings 50
 - (k) Graphic Arts (Sign) Coatings 500
 - (l) Industrial Maintenance (IM) Coatings 100
 - (m) High Temperature IM Coatings 420
 - (n) Zinc-Rich IM Primers 100
 - (o) Metallic Pigmented Coatings 500
 - (p) Multi-Color Coatings 250
 - (q) Nonflat Coatings 50
 - (r) Nonflat High Gloss 50
 - (s) Pigmented Lacquer 275
 - (t) Pre-Treatment Wash Primers 420
 - (u) Primers, Sealers, and Undercoaters 100
 - (v) Quick-Dry Enamels 50
 - (w) Quick-Dry Primers, Sealers, and Undercoaters 100
 - (x) Recycled Coatings 250
 - (y) Roof Coatings 50
 - (z) Rust Preventative Coatings 100
 - (aa) Shellac Clear 730
 - (bb) Shellac Pigmented 550
 - (cc) Specialty Primers 100
 - (dd) Stains 100
 - (ee) Stains, Interior 250
 - (ff) Waterproofing Sealers 100
 - (gg) Waterproofing Concrete/Masonry Sealers 100
 - (hh) Wood Preservatives Below-Ground 350
 - (ii) Wood Preservatives- Other 350
 - (jj) Low-Solids Coating 120
- E. Carpet and Adhesive: Provide products having VOC content not greater than that required for CRI Green Label Plus certification.
1. Evidence of Compliance: Acceptable types of evidence are:
 - a. Current Green Label Plus Certification.
 - b. Report of laboratory testing performed in accordance with requirements.
- F. Carpet Tile and Adhesive: Provide products having VOC content not greater than that required for CRI Green Label Plus certification.
1. Evidence of Compliance: Acceptable types of evidence are:
 - a. Current Green Label Plus Certification.
 - b. Report of laboratory testing performed in accordance with requirements.
- G. Composite Wood and Agrifiber Products and Adhesives Used for Laminating Them: Provide products having no added urea-formaldehyde resins.
1. Evidence of Compliance: Acceptable types of evidence are:
 - a. Current SCS "No Added Urea Formaldehyde" certification; www.scs-certified.com.
 - b. Published product data showing compliance with requirements.
- H. Other Product Categories: Comply with limitations specified elsewhere.

PART 3 EXECUTION**3.01 FIELD QUALITY CONTROL**

- A. Owner reserves the right to reject non-compliant products, whether installed or not, and require their removal and replacement with compliant products at no extra cost to Owner.
- B. Additional costs to restore indoor air quality due to installation of non-compliant products will be borne by Contractor.

END OF SECTION 01 6116

SECTION 01 6200
DELEGATED DESIGN REQUIREMENTS

PART 1 - GENERAL**1.01 SUMMARY**

- A. Administrative and procedural requirements for delegated design indicated in the drawings and the various Sections of these Specifications.

1.02 DELEGATED DESIGN REQUIREMENTS: INCLUDING, BUT NOT LIMITED TO THE FOLLOWING:

- A. Division 05 - Metal stairs
- B. Division 9 - Engineering of light gage steel frame wall and ceiling assemblies and suspended acoustical ceiling assemblies.
- C. Division 21 - Modifications to the Fire Suppression System in the work area.
- D. Division 23 - Seismic Restraint.
- E. Division 26 - Seismic Restraint.
- F. Division 27 - Modifications to the Communications Systems in the work area.
- G. Division 28 - Modifications to the Fire Detection and Alarm Systems in the work area.

1.03 DEFINITIONS

- A. Contractor Design Requirements: Where occurs, same meaning as Delegated Design Requirements.
- B. Delegated Design: Design services and related product selection, drawings, detailing, calculations, code-compliance forms, documentation, and coordination provided by the General Contractor or their subcontractor for specific systems, materials or equipment as described in the contract documents. Delegated Design does not include services the Contractor may need to fulfill their responsibilities under the Contract including but not limited to construction means, methods and sequence.
- C. Seal: Certification that delegated design plans, calculations and specifications were designed and prepared under the direct supervision of the Architect or Engineer whose name appears thereon.
- D. Approval Stamp: Certification obtained by the Contractor that the Building Official has reviewed a submittal, and finds it acceptable with respect to applicable regulatory requirements.

1.04 DELEGATED DESIGN SERVICES

- A. Delegated Design performance, components and their attachments to structure shall comply with the currently adopted edition of all applicable state and local codes and ordinances.
- B. Where professional design services, engineering, or certifications by a registered professional are specifically indicated or required by code or law, provide such services including sealed and signed documentation by a professional registered in the State or Oregon.

1.05 SUBMITTALS

- A. General: Submit complete Delegated Design Submittals to meet permitting agency requirements for permits. Include drawings and calculations for that portion of the Work signed and sealed by a State of Oregon registered architect or engineer. Incomplete submittals or submittals not previously reviewed and so stamped by General Contractor will not be accepted for review by the Architect.
- B. These submittal requirements are in addition to other submittal requirements stated elsewhere in the contract documents.

1.06 QUALITY ASSURANCE

- A. Permitting Agency Requirements: Follow the requirements for permits current at the time of submission. The General Contractor is responsible to coordinate and submit all material required, so the permitting agency's review will not adversely affect the construction schedule. At or near time of application, the General Contractor shall meet with the permitting agency to identify Delegated Design components and how they are to be submitted and processed for permits.

PART 2 – PRODUCTS - NOT USED**PART 3 - EXECUTION****3.01 WORK INCLUDED**

- A. General: Certain of the components of the Work under this project are Delegated Design. It is the General Contractor's responsibility to coordinate and assume or assign to subcontractors the complete responsibility for the design, calculations, submittals, fabrication, transportation and installation of the Delegated Design portions or components as required in this Section.
- B. The General Contractor is responsible to submit all documents required by the permitting agency for the separate approval and permit for each Delegated Design item. Delegated Design components of this Work are defined as complete, operational systems, provided for their intended use.
- C. All permit plan review and permit fees for Delegated Design items are the responsibility of the submitting General Contractor.

DOCUMENTS REQUIRED

- A. General: Delegated Design documents and related permits issuance must be completed prior to fabrication. The General Contractor must complete and submit a Contractor Design Summary Sheet listing Delegated Design Subcontractors and their registered engineer's names and phone numbers prior to submission of the Delegated Design documents for review.
- B. Scope of Documents: Delegated Design components are shown in the Contract Documents for design intent. The purpose is to have the General Contractor responsible to provide, coordinate and install each Delegated Design component.
 - 1. Delegated Design components attached to the structural frame or supplemental to the structural frame shall be designed for the load capacity of the existing structure. These Delegated Design components are all to be coordinated with appropriate subcontractors.
 - 2. Load reactions at the interface between the Delegated Design components and the structural frame shall be clearly defined to allow for a review by the Authority Having Jurisdiction.
- C. Component Certification: Certify that mechanical and electrical components comply with the structural provisions of all applicable codes.
 - 1. Shop Drawings: Submit shop drawings for all attachments to the structure for all elements requiring structural design per these specifications. These attachments include, but are not limited to, structural bracing for equipment, conveyances, and architectural components; seismic restraints of vibration isolation systems; and details of lateral bracing and attachment systems designed to accommodate differential movement between building levels.
 - 2. Shop Drawings shall be sealed by the structural engineer responsible for their design.
- D. Quality Assurance Plan: Submit a quality assurance plan for the designated structural system of all elements requiring structural design per these specifications. Quality assurance plan shall comply with Owner's requirements and all applicable codes.

END OF SECTION 01 6200

SECTION 01 7329
CUTTING AND PATCHING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Requirements and limitations for cutting and patching of Work.

1.02 RELATED SECTIONS

- A. Section 01 25 00, Product Substitution Procedures.
- B. Section 01 33 23, Shop Drawings, Product Data, Samples

1.03 SUBMITTALS

- A. Submit written request in advance of cutting or alteration which affects:
 - 1. Structural integrity of any element of the Work.
 - 2. Efficiency, maintenance, or safety of any operational element.
 - 3. Visual qualities of sight exposed elements.
 - 4. Work of Owner or separate contractor.
- B. Include in request:
 - 1. Identification of project.
 - 2. Location and description of affected work.
 - 3. Necessity for cutting or alteration.
 - 4. Description of proposed work, and products to be used.
 - 5. Alternatives to cutting and patching.
 - 6. Effect on work of Owner or separate contractor.
 - 7. Written permission of affected separate contractor.
 - 8. Date and time work will be executed.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Primary Products: Those required for original installation.
- B. Product Substitution: For any proposed change in materials, submit request for substitution under provisions of Section 01 25 00.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Inspect existing conditions prior to commencing Work, including elements subject to damage or movement during cutting and patching.
- B. After uncovering existing work, inspect conditions affecting performance of Work.
- C. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Provide temporary supports to ensure structural integrity of the Work.
- B. Provide devices and methods to protect other portions of the Work from damage.
- C. Provide protection from elements for areas which may be exposed by uncovering work.

3.03 CUTTING AND PATCHING

- A. Execute cutting, fitting and patching to complete work.
- B. Fit products together, to integrate with other work.
- C. Remove and replace defective or non-conforming work.
- D. Provide openings in the work for penetration of mechanical and electrical work.

3.04 PERFORMANCE

- A. Execute work by methods to avoid damage to other Work, and which will provide appropriate surfaces to receive patching and finishing.
- B. Cut rigid materials using masonry saw or core drill. Pneumatic tools are not allowed without prior approval from Owner's Authorized Representative.
- C. Restore work with new products in accordance with requirements of Contract Documents.
- D. At penetrations of fire rated walls, partitions, ceiling or floor construction, completely seal voids with approved fire rated material, to full thickness of the penetrated element.
- E. Refinishing:
 - 1. Refinish surfaces to match adjacent finish.
 - 2. For continuous surfaces, refinish to nearest intersection or natural break.
 - 3. For an assembly, refinish entire unit.

END OF SECTION 01 7329

SECTION 01 7400
CLEANING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Related requirements specified elsewhere, cleaning for specific products or work: Specification section for that work.
- B. Maintain premises and public properties free from accumulations of waste, debris, and rubbish, caused by operations.
- C. At completion of Work remove waste materials, rubbish, tools, equipment, machinery and surplus materials, and clean all sight-exposed surfaces; leave project clean and ready for occupancy.

1.02 QUALITY ASSURANCE

- A. Standards: Maintain project in accord with applicable safety and insurance standards.
- B. Hazard Control:
 - 1. Store volatile wastes in covered metal containers.
 - 2. Provide adequate ventilation during use of volatile or noxious substances.

1.03 MATERIALS

- A. Use only cleaning materials recommended by manufacturer of surface to be cleaned.
- B. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

1.04 DURING CONSTRUCTION:

- A. Wet down dry materials and rubbish to lay dust and prevent blowing dust.
- B. At reasonable intervals during progress of Work clean site and public properties, and dispose of waste materials, debris and rubbish.
- C. Provide on-site containers for collection of waste materials, debris and rubbish.
- D. Remove waste materials, debris and rubbish from site and legally dispose of at public or private dumping areas off Owner's property.
- E. Vacuum clean interior building areas when ready to receive finish painting, and continue vacuum cleaning on an as-needed basis until project is ready for Substantial Completion or occupancy.
- F. Handle materials in a controlled manner with as few handlings as possible; do not drop or throw materials from heights.

1.05 FINAL CLEANING

- A. Employ experienced workers, or professional cleaners, for final cleaning.
- B. In preparation for Substantial Completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.
- C. Remove grease, dust, dirt, stains, labels, and other foreign materials from exposed interior and exterior finished surfaces.
- D. Remove putty, paint, labels, lubricants, etc., from windows, mirrors, and sash, and then polish, taking care not to scratch glass.
- E. Vacuum carpeting (shampoo where required), removing debris and excess nap.
- F. Repair, patch and touch up marred surfaces to specified finish, to match adjacent surfaces.
- G. Replace air filters where units were operated during construction.
- H. Maintain cleaning until project, or portion thereof, is occupied by Owner.

END OF SECTION 01 7400

SECTION 01 7700
CONTRACT CLOSEOUT

PART 1 GENERAL**1.01 DESCRIPTION**

- A. The requirements specified in this section relate to all Contractors individually performing under these Contract Documents:
 - 1. Project Record Documents.
 - 2. Final review and payment.
- B. Related work specified elsewhere:
 - 1. OSU General Conditions.
 - 2. Shop Drawings, Product Data and Samples, Section 01 33 23.

1.02 PROJECT RECORD DOCUMENTS

- A. The Project Record Documents shall be organized to include the following information:
 - 1. Table of Contents
 - 2. Project Team List
 - 3. Specifications (Including Addenda and Change Orders)
 - 4. Drawings
 - 5. Inspection Reports, as applicable
 - 6. Signed Warranty(ies)
 - 7. Maintenance Instructions
- B. Draft Project Record Documents shall be submitted for review upon 75% completion of the Work.
- C. Project Record Documents shall be submitted electronically to the Owner. Hard copies will not be accepted.
- D. The project team list shall include the name, address, and phone number of the Owner, Contractor, Inspector, Subcontractors, and the materials manufacturers.
- E. Legibly mark each Specification section to indicate actual as-built condition indicating changes in the Work made by addenda or change order or actual materials used and actual manufacturer(s) used.
- F. Maintain current and accurate as-built mark-ups during construction and make available to Owner's Authorized Representative upon request.
- G. Legibly mark the drawings to indicate actual as-built conditions indicating changes in the Work made by addenda or change order or actual conditions which differ from the drawings.
- H. Redraw or provide new drawings as required for a complete as-built set of drawings. The Contractor shall maintain current and accurate as-built mark-ups during construction and make available to Owner's Authorized Representative.
- I. Include inspection reports if applicable.
- J. Include, in a single section, all copies of the Project's labor and material warranties clearly marked to identify the Owner's responsibilities under the terms of each warranty and the section of Work that each warranty covers. One set must be clearly marked as containing original documents.
- K. In the case of an elevator installation, the Contractor's and manufacturer's warranty shall provide for the Owner's right to respond to emergency/car failure situations for the purpose of extricating individuals trapped in the elevator.
- L. Include maintenance instructions complete with technical information and name, address, and phone number of the Contractor(s) and manufacturer(s) of each material and product.

1.03 FINAL REVIEW AND PAYMENT

- A. Prior to completion, the Contractor shall inspect the Work and make a Punch-list noting all items that are incomplete and/or incorrect.
- B. The Contractor shall notify all Subcontractors in writing of incomplete and/or incorrect items. Notify far enough in advance of the completion date that the Work can be completed on schedule. Said Work shall be immediately corrected.
- C. Should conditions prevail which prohibit some elements of the Work from being accomplished, but the work-in-place will perform the primary function (i.e., painting cannot be completed due to high moisture content of masonry walls.) the Contractor shall record the reason with this Punch-list item requesting temporary delay in completion from the Owner in writing.
- D. Notify the Owner in writing that all items are completed and ready for final review or else that the Work product is fully usable, but some listed deficiencies remain to be completed. Submit all record documents at this time.
- E. The Owner will review all documents. When the documents include a Contractor's request for delay in completion, the Owner will review all Work which is certified as complete to the best knowledge of the Contractor. The Owner will also review the listed incomplete Work and assign a value to such uncompleted work.
- F. The Contractor shall make the required corrections to the Work expeditiously. A letter will be addressed to the Contractor informing the Contractor of the project status.
- G. When Contract closeout procedures are completed and all Punch-list deficiencies have been corrected, provide Owner with final corrected Project Record Documents based on Owner's preliminary review. Correct Project Record Documents shall be in electronic format.
- H. Final Completion by the Owner will be documented and the Contractor will receive written notice of acceptance of the Work and notification that final payment may be billed and released.
- I. All warranties shall commence and become effective beginning on the date of Substantial Completion.

END OF SECTION 01 7700

**SECTION 02 4100
DEMOLITION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Selective demolition of building elements for alteration purposes.

1.02 RELATED REQUIREMENTS

- A. Section 01 1000 - Summary: Limitations on Contractor's use of site and premises.
- B. Section 01 5000 - Temporary Facilities and Controls: Security, protective barriers, and waste removal.
- C. Section 01 7000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

PART 3 EXECUTION

2.01 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 3. Provide, erect, and maintain temporary barriers and security devices.
 - 4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 5. Do not close or obstruct roadways or sidewalks without permit.
 - 6. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
 - 7. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.
- B. Do not begin removal until receipt of notification to proceed from Owner.
- C. Protect existing structures and other elements that are not to be removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger.

2.02 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove items indicated on drawings.
- C. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.

1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 3. Verify that abandoned services serve only abandoned facilities before removal.
 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- D. Protect existing work to remain.
1. Prevent movement of structure; provide shoring and bracing if necessary.
 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 3. Repair adjacent construction and finishes damaged during removal work.
 4. Patch as specified for patching new work.

END OF SECTION 02 4100

SECTION 03 3000
CAST-IN-PLACE CONCRETE

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Concrete formwork.
- B. Floors and slabs on grade.
- C. Concrete reinforcement.
- D. Joint devices associated with concrete work.
- E. Miscellaneous concrete elements, including equipment pads, equipment pits, light pole bases, and thrust blocks.
- F. Concrete curing.

1.02 RELATED REQUIREMENTS

- A. Section 01 4000 - Quality Requirements and Delegated Design: Testing and Delegated Design.
- B. Section 07 9200 - Joint Sealants: Products and installation for sealants and joint fillers for saw cut joints and isolation joints in slabs.
- C. Section 32 1313 - Concrete Paving: Sidewalks, curbs and gutters.

1.03 REFERENCE STANDARDS

- A. ACI 117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
- B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).
- C. ACI 301 - Specifications for Concrete Construction; 2020.
- D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).
- E. ACI 305R - Guide to Hot Weather Concreting; 2010.
- F. ACI 306R - Guide to Cold Weather Concreting; 2016.
- G. ACI 308R - Guide to External Curing of Concrete; 2016.
- H. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).
- I. ACI 347R - Guide to Formwork for Concrete; 2014 (Reapproved 2021).
- J. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2020.
- K. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2018.
- L. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2021.
- M. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens); 2021.
- N. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2016.
- O. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).
- P. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019.
- Q. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2019.
- R. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures; 2016.
- S. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2020a.

- T. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2016.
- U. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2021.
- V. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2017.
- W. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures; 2020.
- X. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2018.
- Y. ASTM D471 - Standard Test Method for Rubber Property--Effect of Liquids; 2016a.
- Z. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2018.
- AA. ASTM E1643 - Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2018a.
- BB. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
 - 2. For chemical-resistant waterstops, provide data on ASTM D471 test results.
 - 3. For membrane-forming, moisture emission-reducing, curing and sealing compound, provide manufacturer's installation instructions,.
- C. Mix Design: Submit proposed concrete mix design.
 - 1. Identify all materials and admixtures and the proportion of each; indicate mix design for use at areas of Polished Concrete work per Section 03 3511.
 - a. Indicate material sources for principal constituents.
 - b. For exact mix, including all constituents, for use at areas of Polished Concrete work per Section 03 3511, provide test data demonstrating compliance with shrinkage limitation requirements. The mix shall be tested in accordance with ASTM C157.
 - c. Indicate whether mix is appropriate for pumping.
 - d. Indicate water-cement ratio, slump, and aggregate grading.
 - 2. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.
 - 3. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 - Concrete Quality, Mixing and Placing.
 - 4. Indicate proposed mix design complies with fiber reinforcing manufacturer's written recommendations.
 - 5. Indicate proposed mix design complies with admixture manufacturer's written recommendations.
 - 6. Indicate proposed mix design complies with expansive component manufacturer's written recommendations.
- D. Samples: Submit samples of underslab vapor retarder to be used.
- E. Samples: Submit two, 12 inch long samples of waterstops and construction joint devices.
- F. Test Reports: Submit report for each test or series of tests specified.
- G. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.

- H. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
- B. Admixture Technician: Provide for the Work, an ACI Level 2 Concrete Technician, or other acceptable professional certificate holder, with expert knowledge of the specific products and materials in the mix design including, but not limited to, admixtures. The technician shall approve each mix design proposed for the Work, assist in proportioning concrete materials for optimal results, and advise on proper admixture use, potential undesirable and uncontrolled effects and propose mix adjustment to meet project conditions.
- C. Follow recommendations of ACI 305R when concreting during hot weather.
- D. Follow recommendations of ACI 306R when concreting during cold weather.
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1.
1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixes.
 - c. Ready mix concrete manufacturer.
 - d. Concrete subcontractor.
 - e. Applicator of Polished Concrete finish per Section 03 3511.
 2. Review: special inspection and testing and inspecting agency procedures for field quality control; concrete finishes and finishing; cold- and hot-weather concreting procedures; curing procedures; construction contraction and isolation joints, and joint-filler strips; semirigid joint fillers; forms and form removal limitations; shoring and reshoring procedures; vapor-retarder installation; anchor rod and anchorage device installation tolerances; steel reinforcement installation; floor and slab flatness and levelness measurement; coordination with Section 03 3511 for work of this Section to received Polished Concrete finish; concrete repair procedures; and concrete protection.

PART 2 PRODUCTS

2.01 FORMWORK

- A. Formwork Design and Construction: Comply with guidelines of ACI 347R to provide formwork that will produce concrete complying with tolerances of ACI 117.
- B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
1. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.
 2. Earth Cuts: Do not use earth cuts as forms for vertical surfaces. Natural rock formations that maintain a stable vertical edge may be used as side forms.
 3. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.
 4. Form Ties: Cone snap type that will leave no metal within 1-1/2 inches of concrete surface.

2.02 REINFORCEMENT MATERIALS

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
1. Type: Deformed billet-steel bars.
 2. Finish: Unfinished, unless otherwise indicated.
- B. Reinforcement Accessories:

1. Tie Wire: Annealed, minimum 16 gauge, 0.0508 inch.
2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
3. Provide stainless steel, galvanized, plastic, or plastic coated steel components for placement within 1-1/2 inches of weathering surfaces.

2.03 CONCRETE MATERIALS

- A. Cement: ASTM C150/C150M, Type II - Moderate Portland type.
 1. Maximum alkali content of 0.6 percent.
 2. Acquire cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C33/C33M.
- C. Fly Ash: ASTM C618, Class C or F.
- D. Calcined Pozzolan: ASTM C618, Class N.
- E. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.
- F. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.04 ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.
- D. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
- E. Water Reducing and Accelerating Admixture: ASTM C494/C494M Type E.
- F. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.
 1. Provide pigmented type, with ASTM C979/C979M inorganic pigments.
- G. Accelerating Admixture: ASTM C494/C494M Type C.
- H. Retarding Admixture: ASTM C494/C494M Type B.
- I. Water Reducing Admixture: ASTM C494/C494M Type A.
- J. Shrinkage Reducing Admixture:
 1. ASTM C494/C494M, Type S.

2.05 ACCESSORY MATERIALS

- A. Underslab Vapor Retarder:
 1. Sheet Material: ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. Single-ply polyethylene is prohibited.
 - a. Thickness: 15 mils.
 2. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
 3. Products:
 - a. Henry Company; Moistop Ultra.
 - b. Intoplast Group; Barrier-Bac.
 - c. Poly-America; Husky Yellow Guard.
 - d. ISI Building Products; Viper VaporCheck II
 - e. Raven Industries; Rufco 400SSB.
 - f. Stego Industries, LLC; Stego Wrap Vapor Barrier.
 - g. Tex-Trude, LP; Xtreme Vapor Barrier.
 - h. W. R. Meadows, Inc. PERMINATOR.
 - i. Substitutions: See Section 01 6000 - Product Requirements.
- B. Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.

1. Grout: Comply with ASTM C1107/C1107M.
 2. Height Change, Plastic State; when tested in accordance with ASTM C827/C827M:
 - a. Maximum: Plus 4 percent.
 - b. Minimum: Plus 1 percent.
 3. Minimum Compressive Strength at 48 Hours, ASTM C109/C109M: 2,000 pounds per square inch.
 4. Minimum Compressive Strength at 28 Days, ASTM C109/C109M: 7,000 pounds per square inch.
 5. Products containing aluminum powder are not permitted.
 6. Refer to Structural Specifications on Structural Drawings additional requirements.
- C. Snap Tie Plugs: Concrete plugs set into tie holes:
1. Dayton Superior A54 Snapplugs, concrete gray color.

2.06 BONDING AND JOINTING PRODUCTS

- A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.
- B. Epoxy Bonding System:
1. Complying with ASTM C881/C881M and of Type required for specific application.
 2. Products:
 - a. Adhesives Technology Corporation; Crackbond SLV302, Crackbond LR321, Crackbond LR321 LPL, Ultrabond 2100 LPL, Ultrabond 2100, Ultrabond 1, Ultrabond 2, Ultrabond 4CC, or Ultrabond HS200.
 - b. Dayton Superior Corporation; Slow Set Bonding Agent.
 - c. Kaufman Products Inc.; SurePoxy HM EPL.
 - d. Kaufman Products Inc.; SurePoxy HM Class B.
 - e. SpecChem, LLC; SpecPoxy 1000, SpecPoxy 2000, SpecPoxy 3000, or SpecPoxy 3000FS.
 - f. W.R. Meadows, Inc.; Rezi-Weld Gel Paste, Rezi-Weld Gel Paste State, Rezi-Weld 1000.
- C. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
1. Material: ASTM D1752, sponge rubber (Type I).
- D. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches on center; ribbed steel stakes for setting.

2.07 CURING MATERIALS

- A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
1. Products:
 - a. BASF Confilm.
 - b. L&M E-Con.
 - c. Substitutions: See Section 01 6000 - Product Requirements.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Sheet: ASTM C171.
1. Curing paper, regular.
 2. Polyethylene film, white opaque, minimum nominal thickness of 4 mil, 0.004 inch.
 3. White-burlap-polyethylene sheet, weighing not less than 3.8 ounces per square yard.
- D. Water: Potable, not detrimental to concrete.

2.08 CONCRETE MIX DESIGN

- A. Comply with Structural Specifications on Structural Drawings.
- B. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
 - 1. Replace as much Portland cement as possible with fly ash, ground granulated blast furnace slag, silica fume, or rice hull ash as is consistent with ACI recommendations.
 - 2. Maximum Water-Cement Materials Ratio: Refer to General Structural Notes, except as noted below for Work to receive Polished Concrete Finish per Section 03 3511.
 - 3. Air Content: Add air-entraining to concrete permanently exposed to weather and freeze/thaw cycles at manufacturer's prescribed rate to result in concrete at the point of placement having the air content specified in the General Structural Notes.
 - 4. Slab-on-grade to receive Polished Concrete finish Work of Section 03 3511: Use only one mix design; use of fly ash in this mix is not acceptable. Control potential shrinkage of concrete mix as necessary to effectively mitigate cracks, deformation, and other undesirable characteristics due to loss of excess water of hydration, but in no case shall shrinkage exceed 0.04 percent. Provide evidence of prior success with slabs with Polished Finish similar that required for the Work.
- C. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - 1. Compressive Strength: Comply with Structural Specifications on Structural Drawings.
 - 2. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- D. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.

2.09 MIXING

- A. Transit Mixers: Comply with ASTM C94/C94M.
 - 1. Measure, batch, mix, and deliver concrete according to ASTM C94/C94M and ASTM C1116/C1116M, and furnish batch ticket information.
 - 2. When air temperature is between 85 and 90 degrees F., reduce mixing and delivery time from 90 minutes to 75 minutes; when air temperature is above 90 deg. F., reduce mixing and delivery to 60 minutes.
- B. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

- A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.
- B. Verify that forms are clean and free of rust before applying release agent.
- C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- D. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.
 - 1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
 - 2. Use latex bonding agent only for non-load-bearing applications.

- E. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
 - 1. Vapor Retarder Over Granular Fill: Install compactible granular fill before placing vapor retarder as indicated on drawings. Do not use sand.
- F. Coordinate installation of all inserts and embedded items required or indicated in the construction documents. Embedded items are to be accurately placed and supported against displacement prior to concreting. Voids in sleeves, inserts and anchor bolt slots shall be filled temporarily with a readily removable material to prevent entry of concrete into the voids.

3.03 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

- A. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.
- B. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

3.04 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Notify Architect not less than 24 hours prior to commencement of placement operations.
- C. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- D. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- E. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, joints are to be located as to least impair the strength of the structural element and shall be approved by the Architect and Structural Engineer. Additionally, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
- F. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.
- G. Vibrator and vibrating shall be conducted as follows:
 - 1. Employ as many vibrators and tampers as necessary to secure the desired results. Minimum: one per each 20 cubic yards of concrete placed per hour.
 - 2. Eliminate the following applications: Pushing of concrete with vibrator, external vibration of forms, allowing vibrator to vibrate against reinforcing steel where steel projects into green concrete, and allowing vibrator to vibrate contact faces of forms.
 - 3. Vibrators shall function at a minimum frequency of 3600 cycles per minute when submerged in concrete.
 - 4. Supplement vibration by forking and spading along the surfaces of the forms and between reinforcing whenever flow is restricted.
- H. Locate contraction joints at slabs on grade as indicated on the drawings, but no more than 8 feet maximum spacing. Confirm final layout of joints with Architect prior to installation of slab.
- I. Anchor joint fillers and devices to prevent movement during concrete placement.
- J. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
 - 1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.
- K. Load Transfer Construction and Contraction Joints: Install load transfer devices as indicated; saw cut joint at surface as indicated for contraction joints.

- L. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.
- M. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.
- N. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.05 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
 - 1. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
 - 2. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4-inch in one direction.
 - a. Apply Scratch Finish to surfaces indicated and to surfaces to receive concrete floor topping or morar setting beds for bonded cementitious floor finishes.
 - 3. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
 - a. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing.
 - 4. Trowel Finish: Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI 302.1R; thin floor coverings include carpeting, resilient flooring, seamless flooring, thin set quarry tile, and thin set ceramic tile.
 - a. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - b. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
 - c. Penetrating Clear Sealer: Specified in Section 09 9123 - Interior Painting.
 - 5. Other Surfaces to Be Left Exposed: Trowel as described in ACI 302.1R, minimizing burnish marks and other appearance defects.
- C. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.

3.06 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
 - 1. Curing shall continue for the cumulative number of days or fractions thereof, not necessarily consecutive, during which temperature of the air in contact with the concrete is above 50 degrees F., has totaled the duration listed below:
 - 2. Normal concrete: Not less than seven days.
 - 3. High early strength concrete: Not less than four days.

- C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
- D. Surfaces Not in Contact with Forms:
 - 1. Evaporation Reducer: Apply evaporation reducer to unformed concrete surfaces of slabs receiving Polished Finish work of 03 3511. Apply evaporation reducer to other slabs if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. per hour before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding and bull floating or darbying concrete, but before float finish.
 - 2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 - 3. Final Curing: Begin after initial curing but before surface is dry.
 - a. Moisture-Retaining Sheet: Lap strips not less than 3 inches and seal with waterproof tape or adhesive; secure at edges.
 - b. Absorptive Cover: Place contiguously over concrete surfaces in widest width practical, with edges lapped 4 inches.
 - c. Curing Compound: Not permitted.

3.07 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - Quality Requirements.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- E. Inspections: As indicated in the Statement of Special Inspections and Testing sheets of the structural drawings, except as otherwise indicated.
- F. Concrete Tests: As indicated in the Statement of Special Inspections and Testing sheets of the structural drawings, except as otherwise indicated.
- G. Concrete compressive strength testing: Test as required by OSSC section 1905:
 - 1. Make and cure three specimen cylinders according to ASTM C31 for each 150 cubic yards, or fraction thereof, of each class poured at site each day.
 - 2. Retain one cylinder for 7-day test and two for the 28-day test.
 - 3. Number each cylinder 1A, 1B, 1C, 2A, 2B, 2C, etc; date each set; and keep accurate record of pour each set represents.
 - 4. Transport specimen cylinders from job to laboratory after cylinders have cured for 24-hours on site. Cylinders shall be covered and kept at air temperatures between 60 and 80 degrees Fahrenheit.
 - 5. Test specimen cylinders at age 7-days and age 28-days for specified strength according to ASTM C39.
 - 6. Base strength value on average of two cylinders taken for 28-day test.
- H. The floor flatness and levelness should be tested within 8 hours after completion of the final troweling operation according to ASTM E1155 by an independent testing agency experienced with the testing procedure and possessing the necessary equipment.
 - 1. Out of tolerance work shall be corrected.

3.08 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.

- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.09 PROTECTION

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.
- B. Protect slabs to be polished from damage before and after fully cured and prior to polishing.

END OF SECTION 03 3000

SECTION 05 1200
STRUCTURAL STEEL

PART 1 GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 01 4000 - Quality Requirements and Delegated Design: Design of structural connections if not fully designed.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Structural steel.
 - 2. Prefabricated building columns.
 - 3. Grout.
- B. Related Sections include the following:
 - 1. Section 01 3000 - Administrative Requirements:
 - 2. Section 01 4000 - Quality Requirements: Independent testing agency procedures.
 - 3. Section 09 9113 - Exterior Painting, and Section 09 9123 - Interior Painting: for surface preparation and priming requirements.

1.03 DEFINITIONS

- A. Structural Steel: Elements of the structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.
- B. Heavy Sections: Rolled shapes with flanges thicker than 2 inches (1-1/2 inches for shapes part of the Seismic Load Resisting System (SLRS), and plates exceeding 2 inches in thickness, including base plates, gusset plates, flange plates, end plates, and plates in welded built-up members.
- C. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic load resisting system.
 - 1. For moment frames, complete joint penetration welds in beam-to-column connections, including flange, web and shear plates.
 - 2. For moment frames, complete joint penetration welds of column splices and of columns-to-base plates.
 - 3. Other welds indicated as "Demand Critical" on the drawings.
- D. Protected Zone: Area of SLRS members defined in the drawings in which limitations apply to fabrication and attachments. Such limitations include:
 - 1. Welded shear studs and decking attachments that penetrate the beam flange shall not be placed on beam flanges within the protected zone. Decking arc spot welds are required to secure decking shall be permitted.
 - 2. Within the protected zone, discontinuities created by fabrication or erection aids, air-arc gouging, and thermal cutting shall be repaired as required by the engineer of record.
 - 3. Welded, bolted, screwed, or shot-in attachments for perimeter edge angles, exterior facades, partitions, ductwork, piping, or other construction shall not be placed within the protected zone.
- E. Exposed Structural Steel: Members and connections exposed to view as indicated in the Contract Documents, or in this Specification.
- F. Seismic Load Resisting System (SLRS): Assembly of structural elements in the building that resists seismic loads.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Structural steel shop drawings shall contain sufficient detail and information to allow complete fabrication and erection of the structure without reference to the contract drawings either on the fabrication shop floor or at the project site. The steel detailer shall generate all shop drawing fabrication and installation details from the structural and architectural drawings and specifications. The use of reproductions or photocopies of the contract drawings shall not be permitted. When CAD or REVIT files are provided, it is the responsibility of the detailers to remove all information not directly relevant to the creation of the placing drawings as well as all references to the outside sources of the files.
 - a. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - b. Include embedment drawings.
 - c. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - d. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
 - e. Additional seismic submittal requirements:
 - 1) Identify members and connections that are part of the SLRS as indicated in the construction documents.
 - 2) Locations of demand critical welds.
 - 3) Locations and dimensions of protected zones.
 - 4) Locations of slip critical bolts.
 - 5) Access hole dimensions, surface profile and finish requirements.
 - 6) Locations where backing bars and weld tabs are to be removed.
 - 7) Locations where supplemental fillet welds are required when backing is permitted to remain.
 - 8) Connection assembly sequence where special precautions are required.
 - 9) Non-Destructive Testing (NDT) to be performed where required.
 - 2. Shop drawing re-submittals shall clearly identify all revisions to previous submittals.
 - a. Heavy ink, clouded outlines (revision clouds) shall be drawn around revised areas of individual sheets.
 - b. Engineer/Architect will not review information outside of revision clouds on resubmitted drawings.
 - 3. Separate shop drawing submittal packages shall be made for each of the XX building sectors shown on the contract drawings. The submittal for each sector shall contain complete fabrication and installation/erection information for all elements within that sector. References to shop drawings contained in other shop drawing submittal packages shall not be permitted. Submittal packages for each sector shall be staggered at least 14 calendar days.
- C. Welding Certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Qualification Data: For firms and persons specified in "Quality Assurance" Articles to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- F. Structural steel erection plan detailing sequence and methods of erection.

1. The contractor shall provide a comprehensive engineering analysis, signed and sealed by a structural engineer licensed in the State of Oregon, verifying that the structure erected over occupied space will comply with the current edition of the International Building Code during all phases of construction.
- G. Mill test reports for structural steel, including chemical and physical properties.
- H. Product Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 2. Direct-tension indicators.
 3. Tension-control, high-strength bolt-nut-washer assemblies.
 4. Shear stud connectors.
 5. Shop primers.
 6. Nonshrink grout.
- I. Source quality-control test reports.
- J. Certified Manufacturer's Test Reports
 1. Charpy V-notch toughness as specified in part 2 of this Section for the following:
 - a. Heavy Sections.
 - b. Demand Critical Welds.
- K. Written Welding Procedure Specifications (WPSs): In accordance with AWS D1.1 requirements for each welded joint proposed for use whether prequalified or by testing. Include all welding that will be performed during fabrication (shop) and installation/erection (field) Include the following items as applicable for the welding process:
 1. Indicate as-detailed configuration, and the maximum and minimum fit-up configurations.
 2. Identify specific electrode and manufacturer.
 3. List actual values of welding parameters to be used so clear instruction is provided to welders.
 4. Steel specification(s) and grade(s) to be welded.
 5. Thickness range of materials to be joined.
 6. Type of joint.
 7. Type of weld.
 8. Size of weld.
 9. Position of welding.
 10. Flux and shielding gas.
 11. Electrode diameter.
 12. Voltage (except SMAW).
 13. Current (amperage) or wire feed speed.
 14. Travel speed.
 15. Minimum Preheat and Interpass Temperatures: Provide minimum preheat and interpass temperature for all welds, including tack welds, in accordance with AWS D1.1, Table 3.2. The Contractor may specify higher minimum temperatures as a part of the WPS. Preheat and interpass temperatures lower than those required by AWS D1.1, Table 3.2, are permitted provided the WPS has been qualified by testing. Minimum preheat and interpass temperatures shall be verified at a distance of 3 inches from the joint or for materials over 3 inches in thickness at a distance equal to the thickness of the part.
 16. Maximum Preheat and Interpass Temperatures: The maximum preheat and interpass temperature permitted is 550 degrees F, measured at a distance of 1 inch from the joint. This maximum temperature may not be increased with or without qualification testing.
 17. Number and placement of passes.
 18. Technique (stringer or weave bead).
 19. Shielding gas flow rate.

20. Charpy V-notch toughness as required by this specification.
21. Other pertinent information specific to the weld.
- L. Procedure Qualification Record (PQR): In accordance with AWS D1.1 for all procedures qualified by testing. For welds part of the SLRS qualification testing shall include Charpy V-notch (CVN) testing in accordance with AWS D1.8 and AISC 341-05 Appendix X. The notch specimen shall be located in the weld. If two different filler metals are used, including all tack welds and repairs, then additional CVN specimens shall be taken at the boundary of the two filler metals. Qualify all welds for the maximum heat input to be used on the project.
- M. Manufacturer's Certifications: For all welding electrodes, fluxes, and shielding gasses to be used. Certifications shall satisfy the applicable AWS A5 requirements.
- N. Test Reports: Copies of reports of tests conducted on shop and field bolted and welded connections. Include data on type(s) of tests conducted and test results.
- O. Surveys: Submit certified copies of each survey conducted by a registered land surveyor, showing elevations and locations of base plates and anchor bolts to receive structural steel, and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.
- P. Design Calculations: Submit design calculations, bearing the seal and signature of a Professional Engineer, employed by the Contractor and registered in the state of the project, for the following:
 1. Connections that differ from that indicated in the contract documents.
 2. Requests for substitution of member sizes or material grades.
 3. Modification of the strength or configuration of structural framing for the convenience to accommodate the erection sequence, construction equipment, and/or material availability.
- Q. Quality Assurance Agency Documents: The Agency responsible for quality assurance for members part of the SLRS shall submit QA documents as outlined in AISC 341-05 (seismic provisions) Appendix Q (Q4).
- R. Maintain one copy of each document on-site.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: The installer shall have at least five years experience in this size and type of structure.
- B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category [STD] (standard for building structures).
 1. Fabricator shall be approved by authorities having jurisdiction/the City of Eugene.
- C. Welding Standards: Comply with applicable provisions and qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel", and ASW D1.8, "Structural Welding Code - Seismic Supplement" for members part of the SLRS.
 1. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
 2. Qualifications for Welding Work: Qualify welding personnel in accordance with AWS D1.1, "Qualification," (or approved equal).
 - a. Qualify welders in accordance with AWS D1.1 for each process, position, and joint configuration.
 - b. Welders who have not used the welding process for a period of 6 or more months shall be recertified.
 - c. If recertification of welders is required, retesting will be the Contractor's responsibility.
 - d. WPSs for each joint type shall indicate proper AWS qualification and be available where welding is performed.

- e. Each welder performing demand critical welds shall be qualified by testing in accordance with AWS D1.8 Part 5.
 - f. Welders whose work fails to pass inspection shall be requalified before performing further welding.
- D. Comply with applicable provisions of the following specifications and documents:
- 1. AISC 303 "Code of Standard Practice for Steel Buildings and Bridges" (with exceptions noted in Part 1 of this Section).
 - 2. AISC 341 "Seismic Provisions for Structural Steel Buildings" including Supplement No. 1.
 - 3. AISC 360 "Specification for Structural Steel Buildings, 13th edition.
 - 4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - 5. ASTM A 6 (ASTM A 6M) "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
 - 6. AISC 358-05, "Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications."
- E. Professional Engineer Qualifications: A structural engineer who is licensed in the State of Oregon and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent
- F. Mock-ups: Build mock-ups of Exposed Structural Steel as required by Architect to set quality standards for fabrication and installation.
- 1. Coordinate finish painting requirements with Division 09 Painting Sections.
 - 2. Approved mock-ups may become part of the completed Work if undisturbed at the time of substantial completion.
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off the ground and space by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
- 1. Do not store materials on the structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
- 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 - 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.07 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.08 EXCEPTIONS TO AISC CODE OF STANDARD PRACTICE FOR STEEL BUILDINGS AND BRIDGES

- A. Add the following paragraph to Section 1.8.1 of the AISC Code of Standard Practice for Steel Buildings and Bridges:
1. "The Contractor shall have sole responsibility for site safety. The Fabricator and Erector shall review the Contract Documents and if the structure, as shown on those documents, is in conflict with the requirements of any safety regulations, the Fabricator shall notify the Structural Engineer of Record prior to commencing shop drawing production. If the Fabricator and/or Erector fail to notify the Structural Engineer of Record, as stated above, they shall become responsible for all costs for correcting such conflicts with the requirements of any and all safety regulations."
- B. Add the following paragraph to Sections 7.5.1 and Section 7.5.3 of the AISC Code of Standard Practice for Steel Buildings and Bridges:
1. "The Owner's Designated Representative for Construction shall prepare the Embedment Drawing. The Embedment Drawing shall be submitted to the Structural Engineer of Record for information only. The Structural Engineer of Record shall not be responsible for the review and approval of the Embedment Drawing."
- C. Add the following paragraph to Section 7.10.3 of the AISC Code of Standard Practice for Steel Buildings and Bridges:
1. "The Erector shall have the sole responsibility for determining the means and methods used to properly and adequately brace the framing during erection."
- D. Revise the second paragraph of Section 7.10.3 of the AISC Code of Standard Practice for Steel Buildings and Bridges as follows:
1. "The Erector need not consider loads during erection that result from the performance of work by, or the acts of, others, except as specifically identified by the Owner's Designated Representatives for Design and Construction, nor those that are unpredictable, such as loads due to hurricane, tornado, earthquake, explosion or collision. The Erector shall determine, furnish and install temporary supports to resist earthquake loads specified by the 2012 International Building Code for new buildings."
- E. Revise Section 7.14 of the AISC Code of Standard Practice for Steel Buildings and Bridges as follows:
1. "The correction of minor misfits by moderate amounts of reaming or grinding, welding or cutting, and the drawing of elements into line with drift pins, shall be considered to be normal erection operations. Errors that cannot be corrected using the foregoing means, or that require major welding, cutting or changes in member or Connection configuration, shall be promptly reported to the Owner's Designated Representatives for Design and Construction and the Fabricator by the Erector, to enable the responsible entity to either correct the error or approve the most efficient and economical method of correction to be used by others."
 2. Particular note shall be paid to the commentary for this section of the AISC Code of Standard Practice for Steel Buildings and Bridges, which reads as follows:
 3. "As used in this Section, the term "moderate" refers to the amount of reaming, grinding, welding or cutting that must be done on the project as a whole, not the amount that is required at an individual location. It is not intended to address limitations on the amount of material that is removed by reaming at an individual bolt hole, for example, which is limited by the bolt-hole size and tolerance requirements in the AISC and RCSC Specifications."

PART 2 PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

- A. Structural Steel Shapes, and Bars: Refer to the General Structural Notes.

- B. W-Shapes: Refer to the General Structural Notes.
- C. Channels, Angles: Refer to the General Structural Notes.
- D. Plate and Bar: Refer to the General Structural Notes.
- E. Corrosion-Resisting Structural Steel: ASTM A 588/A 588M, Grade 50 (345).
- F. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- G. Steel Pipe: Refer to the General Structural Notes.
- H. Welding Electrodes: Comply with AWS requirements.
 - 1. Welding electrodes shall have a minimum tensile strength of 70 ksi using AWS A5 classification test.
 - 2. Welding filler metals, as supplied by the manufacturer, shall meet the requirements for H16 (16 mL diffusible hydrogen per 100 grams deposited weld metal) as tested using the mercury or gas chromatograph method as specified in AWS A4.3, "Standard Methods for Determination of Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding." The manufacturer's Certificate of Conformance shall be considered adequate proof that the supplied electrodes meet this requirement, and no additional testing of filler metal samples or of production welds is required.
 - 3. All low hydrogen electrodes shall be stored, handled, protected from atmospheric exposure and redried, if required, per AWS D1.1, 5.3.
 - 4. FCAW electrodes shall be received in moisture-resistant packages that are undamaged. They shall be protected against contamination and injury during shipment and storage. Electrode packages shall remain effectively sealed against moisture until the electrode is required for use. When removed from the protective packaging and installed on machines, care shall be taken to protect the electrodes and coatings, if present, from deterioration or damage. Modification or lubrication of an electrode after manufacture for any reason is not permitted, except drying shall be permitted when recommended by the manufacturer.
 - 5. Welds used in members and connections in the SLRS shall be made with a filler metal that can produce welds that have a minimum Charpy V-Notch (CVN) toughness of 20 ft-lbs at 0 degrees F, as determined by the appropriate AWS A5 classification test methods.
 - 6. For welded joints defined as demand critical, welding filler metals shall provide the following minimum mechanical property requirements in the designated testing as described below:
 - a. Charpy V-Notch (CVN) Toughness: 20 ft-lb at -20 degrees F using AWS A5 classification test methods.
 - b. CVN Toughness: 40 ft-lb at 70 degrees F using AISC 341-05 (seismic provisions), Appendix X.
 - c. Yield Strength: 58 ksi minimum using the AWS A5 classification test.
 - d. Elongation: 22 percent using the AWS A5 classification test
 - 7. Heavy sections with complete joint penetration (CJP) weld splices: Welding filler metals shall have a minimum Charpy V-Notch (CVN) toughness of 20 ft-lbs at 70 degrees F.
 - 8. Electrodes for use with ASTM A588 base metal shall have strength, corrosion resistance and weathered appearance similar to that of the base metal.

2.02 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.
 - 1. Finish: Plain.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers, plain.

- C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- D. Headed Anchor Rods: ASTM F 1554, Grade As Noted, straight.
 - 1. Nuts: ASTM A 563 (ASTM A 563M) heavy hex carbon steel.
 - 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 3. Washers: ASTM F 436 (ASTM F 436M) hardened carbon steel.
 - 4. Finish: Plain or Hot-dip zinc coating, Refer to Structural Drawings.
- E. Threaded Rods: As noted on Structural Plans.
 - 1. Nuts: ASTM A 563 (ASTM A 563M) heavy hex carbon steel.
 - 2. Washers: [ASTM F 436 (ASTM F 436M) hardened] [ASTM A 36/A 36M] carbon steel.
 - 3. Finish: Plain or Hot-dip zinc coating, As noted on Structural Drawings.

2.03 PRIMER

- A. Primer: Comply with Section 09 9113 - Exterior Painting and Section 09 9123 - Interior Painting.
- B. Galvanizing Repair Paint: ASTM A 780.

2.04 GROUT

- A. Nonmetallic, Non-Shrink Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to a consistency suitable for application and a 30-minute working time

2.05 FABRICATION

- A. Structural Steel: Fabricate and assemble in the shop to the greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" (with exceptions noted in Part 1 of this Specification Section).
 - 1. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
 - 4. Mark and match-mark materials for field assembly.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
 - 6. Sandblast all exposed surfaces of weathering steel. Sandblasting shall be performed in accordance with SSPC-SP6 "Commercial Blast Cleaning" SSPC's Steel Structures Painting Manual. The appearance of the blast cleaned surface shall approximate Pictorial Standard Sa 2 of SSPC-VIS 1, "Pictorial Surface Preparation Standards for Painting Steel Surfaces" except no mill scale particles shall be allowed; only rust or mill scale stains down in the profile will be allowed. The use of acids to remove scale and stains in the field will not be permitted.
 - a. Exposed surfaces of steel contaminated with stains, oil, or foreign material after the above sand blasting cleaning process shall be promptly cleaned as directed by the Owner to preserve conditions for uniform weathering of steel.
 - 7. Store weathering steel in a location which will prevent uneven weathering. Store on blocking to prevent contact with ground.
- B. Re-Entrant Corners: Provide ½-inch radius at all re-entrant corners, unless noted otherwise.
- C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- D. Bolt Holes: Cut, drill, or punch bolt holes perpendicular to metal surfaces.
- E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

- F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning".
- G. Shear Connectors: Prepare steel surfaces as recommended by the manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- H. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not enlarge holes by burning. Thermal cutting of holes is permitted with a surface roughness profile not exceeding 1,000 micro-inches as defined in ASME B46.1.
 - 2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
- I. Fabricate flange cuts of Reduced Beam Sections (RBS) in accordance with AISC 358-05.
- J. Complete joint penetration weld splices in heavy sections:
 - 1. Weld access holes shall be detailed in accordance with AISC Manual Section J1.6.
 - 2. Thermal cut surface preparation and inspection requirements shall be in accordance with AISC Manual Section M2.2.
- K. Exposed Structural Steel: For structural steel exposed at the interior and exterior locations.
 - 1. Fit and shop assemble items in largest practical sections for delivery to site.
 - 2. Fabricate items with joints tightly fitted and secured.
 - 3. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting rust, scale, seam marks, roller marks, rolled trade names, and roughness.
 - 4. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
 - 5. Supply components required for anchorage of fabrications. Fabricate anchors and related components of the same material and finish as fabrication, except where expressly noted otherwise.

2.06 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for the type of bolt and type of joint specified.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work. For connections part of the SLRS, comply with additional requirements of AWS D1.8 - seismic supplement.
 - 1. For non-moment connections, remove backing bars or runoff tabs, back gouge, and grind steel smooth.
- C. Erection Connections, etc: Place holes, plates, or other attachments required by the Erector so as not to interfere with or cause any other detrimental effect to structural members or their connections. Holes and attachments are not permitted in the "protected zone" as described in Section 1.3 and defined in the drawings.
- D. Exposed Steel Shop Connections:
 - 1. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small, uniform radius.
 - 2. Continuously seal joined members by intermittent (stitch) welds and plastic filler.
 - 3. Verify that weld sizes, fabrication sequence, and equipment used will limit distortions to allowable tolerances. Prevent weld show-through.

4. Exposed mechanical fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where noted otherwise.

2.07 SHOP PRIMING

- A. Refer to Section 09 9113 - Exterior Painting and Section 09 9123 - Interior Painting for additional preparation and priming and requirements.
- B. Shop prime steel surfaces except the following:
 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 2. Surfaces to be field welded.
 3. Surfaces to be high-strength bolted with slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials.
 5. Galvanized surfaces.
- C. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 1. SSPC-SP 2, "Hand Tool Cleaning."
 2. SSPC-SP 3, "Power Tool Cleaning."
- D. Exposed Steel Surface Preparation: Clean surfaces of exposed structural steel to the following specifications and standards:
 1. SSPC-SP6, "Commercial Blast Cleaning".
- E. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

2.08 DIMENSIONAL TOLERANCES

- A. Fabrication Tolerances: Unless otherwise noted, fabricate structural members to referenced AISC Specifications for allowable tolerances. Do not camber in excess of amounts shown on drawings.
 1. Reduced Beam Section Cut
 - a. Thermal cutting tolerances shall be plus or minus 1/4-inch from the theoretical cut line.
 - b. The beam effective flange width at any section shall have a tolerance of plus or minus 3/8-inch.
 - c. The location of the center of the radius, with respect to the near face of the column, shall have a maximum variation of plus 0-inch, minus 1/4-inch.

2.09 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
 1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
 2. Weep holes shall be provided at exterior closed sections where moisture may accumulate. Sizes shall be in accordance with ASTM A123.
 3. Galvanize steel exposed to the exterior, and steel to be sprayed with fire-resistive materials and exposed to the exterior.
 4. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

5. Materials for galvanizing shall be geometrically suitable for galvanizing as specified in ASTM A384 and A385. For built-up members, assemblies shall be fabricated as required to limit warping and distortion.
- B. Steel that will be finished by hot dip galvanizing shall have controlled silicon and phosphorus contents. The silicon content shall be in either of the ranges 0 - 0.04% or 0.15% - 0.25%, the phosphorus content shall be below 0.04%. Before galvanizing, submit mill test certificates verifying silicon and phosphorus contents to the Architect and galvanizer.
- C. Bolts, nuts and washers, and iron and steel hardware components shall be galvanized by the hot-dip process in accordance with ASTM A 153.
- D. Surface Preparation: Steel shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter: Clean steel in accordance with Steel Structures Painting Council (SSPC) SSPC-SP-6, "Commercial Blast Cleaning."
- E. Coating Requirements
 1. Weight: The weight of the galvanized coating shall conform to Table 2 of ASTM A 123 or Table 1 of ASTM A 153, as appropriate.
 2. Surface Finish: The galvanized coating shall be continuous, adherent, as smooth and evenly distributed as possible, and free from any defect that is detrimental to the stated end use of the coated article.
 - a. Determine the integrity of the coating by visual inspection and coating thickness measurements.
 - b. Where slip factors are required for slip-critical connections, these shall be obtained after galvanizing by suitable treatment of the faying surfaces in accordance with the latest edition of the Specification for Structural Joints Using ASTM A 325 or A 490 bolts as approved by the Research Council on Structural Connections of the Engineering Foundation.
 3. Adhesion: The galvanized coating shall be sufficiently adherent to withstand normal handling during transport and erection.
- F. Touch-Up and Repair
 1. Mechanical Damage: Repair areas damaged by welding; flame cutting; or during handling, transport, or erection in accordance with ASTM A 780 by one of the following methods:
 - a. Cold Galvanizing Compound (zinc-rich paint): Per Part 2, "Primer" Article, in accordance with ASTM A 780, Annex A2.
 - 1) Spray- or brush-apply the touch-up paint in multiple coats to a dry film minimum thickness of a 6 mils (4 mils for material less than 1/4-inch thick). Apply a finish coat of aluminum paint to provide a color blend with the surrounding galvanizing.
 - 2) Verify coating thickness by measurements with a magnetic or electromagnetic gauge.
 - b. Zinc-Based Solder: In accordance with ASTM A 780, Annex A1.
 - 1) Apply the zinc-based solder in a minimum thickness of 4 mils (3 mils for material less than 1/4-inch thick).
 - 2) Verify coating thickness by measurements with a magnetic or electromagnetic gauge.
 - c. Flame-Sprayed Zinc (metalizing): In accordance with ASTM A 780, Annex A3.
 - 1) Apply sprayed zinc coating in a minimum thickness of 4 mils (3 mils for material less than 1/4-inch thick).
 2. Wet Storage Stain

- a. Remove any wet storage stain if formed and discovered prior to leaving the galvanizer's plant unless late pick up or acceptance of delivery has necessitated the material being stored in unfavorable conditions. Remove wet storage stain before installation so that premature failure of the coating will not occur. Remove wet storage stain as follows:
 - 1) Arrange the object so that their surfaces dry rapidly.
 - 2) Remove light deposits by means of a stiff bristle (not wire) brush. Heavier deposits are to be removed by brushing with a 5 percent solution of sodium or potassium dichromate with the addition of 0.1 percent by volume of concentrated sulfuric acid. Apply with a stiff bristle brush and leave for approximately 30 seconds before thoroughly rinsing and drying.
 - 3) Alternatively, a proprietary product, such as Oakite Highlite or equal, which is intended for this purpose, may be used according to manufacturer's recommendations.
 - 4) Check coating thickness in the affected areas to ensure that the zinc coating remaining after the removal of wet storage stain is sufficient to meet or exceed the requirements of the specification.

2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspection agency to inspect shop welds and high-strength bolted connections and tests, and to prepare test reports in accordance with "Testing and Inspection" Article 3.6.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.03 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 "Code of Standard Practice for Steel Buildings and Bridges" with the exception noted in Part 1 of this Specification Section, and AISC 360 "Specification for Structural Steel Buildings".
- B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean the bottom surface of the base and bearing plates.
 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 2. Weld plate washers to top of base plate.
 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 1. Level and plumb individual members of structure.
 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- D. Splice members only where indicated.
- E. Do not use thermal cutting during erection, unless it conforms to the requirements of AISC 360 Specification Sections M2.2 and M2.5.
- F. Do not enlarge unfair holes in members by burning or using drift pins.
- G. Reaming: Light drifting will be permitted to draw the parts together but drifting to match unfair holes will not be permitted. Any enlargement of holes necessary to make connections in the field shall be done by reaming with twist drills, care being taken not to weaken the adjoining metal. If, in the judgement of the Engineer/Architect, the extent of the reaming is such that holes cannot be properly filled or accurately adjusted after reaming, the faulty member shall be discarded and replaced with a new one, and all costs and expenses resulting therefrom shall be paid by the Contractor.
- H. Cutting and Fitting: No cutting of sections, either flanges, webs, stems or angles shall be done by the Contractor without the consent of the Engineer/Architect, unless this cutting is particularly specified or shown on the drawings
- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- J. Corrective Measures
 1. Any errors in locations or inaccuracies in the setting of anchor bolts, base plates, bearing plates, or other items of attachment or support for steel work shall be reported to the Engineer/Architect and shall be corrected in a manner subject to the approval of the Engineer/Architect.
 2. Any misfits due to errors in fabrication shall be reported immediately to the Engineer/Architect, along with proposed method of correction of same and Engineer/Architect approval obtained before proceeding with corrective measures.
 3. No members shall be cut or burned without specific approval in writing.
 4. Bolted or welded connections, joints, or fastenings, which are classified as defective in the opinion of the Engineer/Architect, shall be corrected by the Contractor in a manner subject to the Engineer/Architect's approval.
- K. Guardrails, Handrails and Ladders: All welds and sharp edges shall be ground smooth.

3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work. For connections part of the SLRS, comply with additional requirements of AWS D1.8 - seismic supplement.

1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" (with exceptions noted in Part 1 of this Specification Section) for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. For non-moment frame connections, remove backing bars or runoff tabs, back gouge, and grind steel smooth (for moment frames, reference Item 5 below).
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
4. Heavy Sections: Complete penetration groove weld in accordance with tension splice requirements of AISC Specification Section J1.5.
5. For demand critical welds, comply with AWS D1.8 - seismic supplement including the following requirements:
 - a. Use electrodes specified for demand critical welds.
 - b. At beam flange to column welds, remove bottom backing bars, back gouge, grind smooth, and back weld with a 5/16 inch reinforcing fillet.
 - c. Where top backing bars remain, a 5/16-inch fillet weld shall be placed between the remaining fusible backing bar at the beam flange and the column. A reinforcing fillet shall not be placed between the backing bar and the underside of the beam flange.
 - d. Cut-off runoff plates (weld tabs) 1/8-inch from edges and grind smooth (not flush). The edges where weld tabs are removed shall be finished to a surface roughness of 500 micro-inches or better. The contour of the weld end shall provide a smooth transition to adjacent surfaces. Weld defects greater than 1/16 inch deep shall be excavated and repaired in compliance with an approved WPS.
 - e. All tack welds not incorporated into the final weld shall be removed.
 - f. Bottom flange welding sequence: When using weld access holes to facilitate CJP groove welds of beam bottom flanges to column flanges or continuity plates, the groove weld shall be sequenced as follows:
 - 1) As far as practicable, starts and stops shall not be placed directly under the beam web.
 - 2) Each layer shall be completed across the full width of the flange before beginning the next layer.
 - 3) For each layer, the weld starts, and stops shall be on the opposite side of the beam web, as compared to the previous layer.
6. The use of copper backing bars are permitted in the WPS and welding under the following restrictions:
 - a. The maximum root opening shall not exceed 7/16-inch. Root openings exceeding 7/16-inch shall use steel or ceramic backing bars.
 - b. The WPS using copper backing bars shall be qualified by testing, per AWS D1.1, that they meet the following additional requirements:
 - 1) The weld metal of the root pass shall be analyzed for copper content. Copper shall not exceed 0.15 percent.
 - 2) The weld metal of the root shall be tested for Charpy V-notch toughness values per AWS D1.1, Annex 3, except the CVN specimen shall be taken a maximum of 1/16-inch from the bottom of the test plate. The weld metal shall meet or exceed 20 foot/pound at -20 degrees F.
7. Tack welds incorporated into the final weld and weld repairs of demand critical welds shall be of the same quality as the final welds, including preheat requirements. The filler metals shall be identical, unless qualified by testing and meeting the requirements of Specification 051200, Part 1, "Submittals" article.
8. FCAW electrodes shall be protected from atmospheric exposure as follows:

- a. Electrodes not consumed within 24 hours of accumulated exposure outside closed or heated storage shall not be used for seismic critical welds.
 - b. Electrode spools shall be identified and monitored for total atmospheric exposure time. Electrodes that have been exposed for periods exceeding an accumulated 24 hours may be dried when manufacturer's recommendations show that drying is effective at removing moisture and restoring electrodes to their designated diffusible hydrogen level. Dry as specified by the manufacturer. If the electrode or the electrode spool is damaged by baking, the electrode shall not be used.
9. Each Welder working on the project shall be assigned an identification symbol or mark. Each Welder shall mark or stamp this identification symbol at each weldment completed and inspected by the welder. Stamps, if used, shall be low-stress type. All welds shall be marked or stamped.
- C. Erection Connections, etc: Place holes, plates, or other attachments required by the Erector so as not to interfere with or cause any other detrimental effect to structural members or their connections. Holes and attachments are not permitted in the "protected zone" as described in Section 1.3 and defined in the drawings.
- D. Exposed Steel Field Connections:
1. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small, uniform radius.
 2. Continuously seal joined members by intermittent (stitch) welds and plastic filler.
 3. Verify that weld sizes, fabrication sequence, and equipment used will limit distortions to allowable tolerances. Prevent weld show-through.
 4. Exposed mechanical fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where noted otherwise.
 5. Remove erection bolts; fill holes with plug welds and grind smooth.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to provide inspection and required tests, and to prepare test reports in accordance with "Testing and Inspection" Article 3.6 below.

3.06 TESTING AND INSPECTION

- A. All structural steel work is subject to special inspection. Testing Agency and Inspector Requirements:
1. Special Inspector: Testing Agency shall provide qualified "Special Inspector" who will perform the inspection services.
 2. Testing agency will conduct and interpret tests, and state in each report whether test specimens comply with or deviate from requirements.
 3. Testing agency will notify the Owner and Engineer/Architect immediately of discrepancies in the work which are time-critical or affect the construction progress.
 4. Personnel inspecting connections part of the SLRS shall be qualified per Section 1.5 "Quality Assurance".
- B. Fabrication Inspection: When approved by the Building Official, the Owner, and Engineer/Architect, full-time special inspection in the fabrication shop by the Owner's Testing Agency may be waived, subject to the following:
1. The Fabricator participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant.
 2. All shop inspection is provided by the Contractor, per the requirements herein, and is documented. Reports and test results are to be available for the Owner's Inspector to review.

3. A specific quality control plan for this project shall be developed and submitted to the Structural Engineer for approval prior to the prefabrication/pre-erection meeting.
 4. Periodic inspection by the Owner's Inspection Agency is allowed by the Fabricator.
 5. Certified Plants: Continuous plant inspection is not required at plants producing prefabricated steel products which are certified by the Building Official.
- C. Contractor Responsibilities Related to Shop and Field Inspections:
1. Maintain complete records of all quality control and testing performed by the Contractor.
 2. Furnish all electrical power, turning or moving of members, hoisting, staging, and other facilities required for inspection.
 3. Provide testing agency with access to places where structural steel work is being fabricated or erected so required inspection and testing can be accomplished.
 4. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
 5. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
 6. Grant Inspectors full authority to inspect all material and work that fails to conform in every respect to these specifications.
 7. When required by Engineer/Architect or Owner's Independent Testing Agency or Contractor's engaged inspection organization, make adequate platforms available to the Inspector for the purpose of checking high-strength bolts and welds. Scaffolding shall be provided to ensure safe performance of this operation.
- D. Shop and Field Tests and Inspections: Inspections and testing shall be performed as indicated in the Contract Documents. Additional requirements are as follows:
1. Welded Connections: In addition to visual inspection, welded connections will be tested and inspected as required by the Contract Documents and Specifications, according to AWS D1.1. Inspection procedures at Testing Agency's option, are listed below:
 - a. Procedures
 - 1) Liquid Penetrant Inspection: ASTM E 165.
 - 2) Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3) Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
 - 4) Ultrasonic Inspection: ASTM E 164.
 - b. Inspector shall:
 - 1) Verify Welding Procedure Specifications (WPSs) sheet has been provided and has been reviewed with each welder performing the weld. Welds not executed in conformance with the WPSs are rejectable.
 - 2) Verify fit-up meets tolerances of WPSs and mark joint prior to welding.
 - 3) Verify welding consumables per WPSs.
 - 4) Verify welding qualification and identifications.
 - 5) Observe preheat and interpass temperatures, and weld pass sequence for conformance with WPSs.

- 6) Nondestructive test all complete penetration groove welds for conformance with weld quality and standard of acceptance per requirements for testing of welds subject to tensile stress by ultrasonic methods in AWS D1.1. Pass sound through entire weld volume from two crossing directions to the extent feasible.
Nondestructive test all complete penetration groove welds of beam flanges to column flanges and column stiffeners and cap plates, and all complete penetration groove welds of column splices and columns to base plates for conformance with weld quality and standard of acceptance per requirements for testing of welds by magnetic particle testing in AWS D.1 in addition to ultrasonic testing methods.
 - 7) All partial penetration, fillet, and other remaining welds shall be visually inspected.
 - 8) Where ultrasonic testing is performed, the entire weld shall be tested.
 - c. Ultrasonically test base metal thicker than 1 1/2 inches after welding is completed for discontinuities behind welds in accordance with IBC Section 1708.4.
 - d. For connections part of the SLRS, including Demand Critical Welds, non-destructive testing (NDT) requirements shall comply with AISC 341-05 (seismic provisions) Appendix Q (Q5.2).
 - e. For Demand Critical Welds, inspect removal of backup bars and runoff plates, preparatory grinding, and execution of reinforcing fillet.
 - f. Test column webs for cracking using dye penetrant or magnetic particle test over 3-inch minimum zone above and below continuity (stiffener) plates after welding. All cracks shall be reported to the Engineer, repaired, and retested. No cracks will be permitted in the final construction.
2. Welded Headed Studs: In addition to visual inspection, welded headed stud connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:
 - a. Bend tests will be performed when visual inspections reveal either less than a continuous 360-degree flash or many cases requiring welding repairs to any welded headed stud connector.
 - b. Tests will be conducted on additional welded headed stud connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.
 3. All slide-bearing assemblies to be inspected for damage, and for scratched or soiled surfaces.

3.07 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint or zinc-based solder according to ASTM A 780 and manufacturer's written instructions. At a minimum, the repair material thickness shall match that of the existing coating.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 2. Apply a compatible primer of the same type as shop primer used on adjacent surfaces.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Section.

END OF SECTION 05 1200

SECTION 05 5000
METAL FABRICATIONS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Shop fabricated steel and aluminum items.
- B. Structural steel stair framing and supports.
- C. Guardrails and handrails.

1.02 RELATED REQUIREMENTS

- A. See Structural Drawings for additional specification information.
- B. 01-4000 - Quality Requirements and Delegated Design.
- C. Section 03 3000 - Cast-in-Place Concrete: Placement of metal fabrications in concrete.
- D. Section 05 1200 - Structural Steel Framing: Structural steel column anchor bolts.
- E. Section 05 5213 - Pipe and Tube Railings.
- F. Section 09 9113 - Exterior Painting: Paint finish.
- G. Section 09 9123 - Interior Painting: Paint finish.

1.03 REFERENCE STANDARDS

- A. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling; 2014.
- B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- C. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2021a.
- D. ASTM A780/A780M-09 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- E. ASTM E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings; 2000 (Reapproved 2006).
- F. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- G. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- H. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- I. ASTM D6386 - Practice for Preparation of Zinc (Hot-Dip Galvanized) Coating Iron and Steel Product and Hardware Surfaces for Painting.
- J. ASTM D7803 - Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating.
- K. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- L. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2014 (Amended 2015).
- M. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).
- N. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2014, with Errata (2020).
- O. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172; 2019.
- P. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.
- Q. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.
- R. SSPC-SP 2 - Hand Tool Cleaning; 2018.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
 - 2. Design data: Submit drawings and supporting calculations, signed and sealed by a qualified professional structural engineer.
 - a. Include the following, as applicable:
 - 1) Design criteria.
 - 2) Engineering analysis depicting stresses and deflections.
 - 3) Member sizes and gauges.
 - 4) Details of connections.
 - 5) Support reactions.
 - 6) Bracing requirements.
- C. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- D. Designer's Qualification Statement.
- E. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172.
- F. Samples: Provide samples of exposed to view Interior Metal Fabrications, including proposed shop finishes. Consult with Architect on proposed approach to "blackened steel" and finish technique prior to fabrication.

1.05 QUALITY ASSURANCE

- A. Design elements that are not fully detailed to meet AHJ requirements, under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M and dated no more than 12 months before start of scheduled welding work.
- C. Fabricator Qualifications: A qualified steel fabricator that is accredited by IAS AC172.

PART 2 PRODUCTS**2.01 MATERIALS - STEEL**

- A. Steel Materials: Refer to Structural Drawings.
 - 1. Exterior Steel or steel penetrating the exterior envelope: Galvanized, unpainted, unless noted otherwise.
- B. Mechanical Fasteners: Same material as or compatible with materials being fastened; type consistent with design and specified quality level.
- C. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- D. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- E. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.
- F. Anchors: As required to suit and complete application.

2.02 MATERIALS - ALUMINUM

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.
- B. Sheet Aluminum: ASTM B209/B209M, 5052 alloy, H32 or H22 temper.

2.03 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Continuously seal joined members by continuous welds.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- F. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.04 ARCHITECTURAL FABRICATED ITEMS

- A. South and East Canopy
 - 1. Material: Steel.
 - 2. Finish: Powder Coating, High Performance: See Section 09 6000 - High Performance Coatings.
- B. Exterior guardrail:
 - 1. Material: Steel.
 - 2. Finish: Powder Coating, High Performance: See Section 09 6000 - High Performance Coatings.

2.05 MISCELLANEOUS FABRICATED ITEMS

- A. Miscellaneous architectural and structural components as identified in drawings, including but not limited to terrace railings, ground floor bathroom lavatories, and various structural and decorative architectural steel connectors. Colors are generally black, unless noted otherwise.
- B. Countertop support brackets and plates: steel plate.
- C. Downspouts:
 - 1. Materials: Steel pipe, schedule 40, with fabricated steel plate brackets as detailed.
 - 2. Support Brackets: Galvanized.
 - 3. Finish: Galvanized and painted.

2.06 FINISHES - STEEL

- A. Prime paint steel items.
 - 1. Exceptions: Galvanize items to be embedded in concrete, items to be imbedded in masonry, and items specified for Galvanized finish.
 - a. Exterior steel, or steel that penetrates to the exterior: Galvanized.
 - 2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
 - 3. Prepare surfaces to be primed in accordance with SSPC-SP2.
 - 4. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
 - 5. Prime Painting: One coat.
 - 6. See Section 09-9113 Exterior Paint, for Exterior Exposed Steel Paint System.
 - 7. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements.
 - 8. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.

2.07 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch.

- C. Maximum Misalignment of Adjacent Members: 1/16 inch.
- D. Maximum Bow: 1/8 inch in 48 inches.
- E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Furnish setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components as indicated on drawings.
- D. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Obtain approval prior to site cutting or making adjustments not scheduled.
- F. After erection, prime welds, abrasions and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 05 5000

SECTION 06 1000
ROUGH CARPENTRY

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Structural dimension lumber framing.
- B. Exposed timber structural framing.
- C. T&G Wood decking
- D. Nonstructural dimension lumber framing.
- E. Rough opening framing for doors, windows, and roof openings.
- F. Sheathing.
- G. Preservative treated wood materials.
- H. Miscellaneous framing and sheathing.
- I. Communications and electrical room mounting boards.
- J. Concealed wood blocking, nailers, and supports.
- K. Miscellaneous wood nailers, furring, and grounds.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Setting anchors in concrete.
- B. Section 05 1200 - Structural Steel Framing: Prefabricated beams and columns for support of wood framing.
- C. Section 05 5000 - Metal Fabrications: Miscellaneous steel connectors and support angles for wood framing.
- D. Section 07 2500 - Weather Resistive Barriers (WRB): Water-resistive barrier over sheathing.
- E. Section 07 6200 - Sheet Metal Flashing and Trim: Sill flashings.
- F. Section 09 2116 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.03 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- C. ASTM C557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing; 2003 (Reapproved 2017).
- D. ASTM D3498 - Standard Specification for Adhesives for Field-Gluing Wood Structural Panels (Plywood or Oriented Strand Board) to Wood Based Floor System Framing; 2019a.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- F. AWC (WFCM) - Wood Frame Construction Manual for One- and Two-Family Dwellings; 2018, with Errata (2019).
- G. AWWA U1 - Use Category System: User Specification for Treated Wood; 2018.
- H. PS 1 - Structural Plywood; 2019.
- I. PS 2 - Performance Standard for Wood-Based Structural-Use Panels; 2010.
- J. PS 20 - American Softwood Lumber Standard; 2020.
- K. WWPA G-5 - Western Lumber Grading Rules; 2017.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide technical data on insulated sheathing, wood preservative materials, and application instructions.

- C. Structural Composite Lumber: Submit manufacturer's published structural data including span tables, marked to indicate which sizes and grades are being used; if structural composite lumber is being substituted for dimension lumber or timbers, submit grading agency structural tables marked for comparison.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

1.06 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a two-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
 - 3. Lumber of other species or grades is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
- B. All composite wood and laminate adhesives shall be No Added Urea Formaldehyde (NAUF).

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Western Wood Products Association; WWPA G-5.
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: S-dry or MC19.
- D. Stud Framing (2 by 2 through 2 by 6):
 - 1. Grade: No. 2, unless noted otherwise in the Structural Drawings.
- E. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

2.03 TIMBERS FOR CONCEALED APPLICATIONS

- A. Grading Agency: Western Wood Products Association; WWPA G-5.
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: S-dry (23 percent maximum).
- D. Beams and Posts 5 inches and over in thickness:
 - 1. Species: Douglas Fir-Larch.
 - 2. Grade: As indicated in the Structural Drawings.

2.04 STRUCTURAL COMPOSITE LUMBER

- A. At Contractor's option, structural composite lumber may be substituted for concealed dimension lumber and timbers.
- B. Structural Composite Lumber: Factory fabricated beams, headers, and columns, of sizes and types indicated on drawings; structural capacity as published by manufacturer.

2.05 CONSTRUCTION PANELS

- A. Subflooring: As indicated in the Structural Drawings.
 - 1. Bond Classification: Exterior.
 - 2. Span Rating: As indicated in the Structural Drawings.
- B. T&G wood decking.
 - 1. Size: As indicated in the structural drawings.
 - 2. Species: Douglas Fir.
 - 3. Span Rating: As indicated in the structural drawings.
- C. Roof Sheathing: PS 2 type, rated Structural I Sheathing.
 - 1. APA PRP-108.
 - 2. Bond Classification: Exterior.
 - 3. Span Rating: As indicated in the Structural Drawings.
- D. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
- E. Other Applications:
 - 1. Plywood Concealed From View But Located Within Exterior Enclosure: PS 1, C-C Plugged or better, Exterior grade.
 - 2. Plywood Exposed to View But Not Exposed to Weather: PS 1, A-D, or better.
 - 3. Other Locations: PS 1, C-D Plugged or better.

2.06 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 - 2. Drywall Screws: Bugle head, hardened steel, power driven type, length three times thickness of sheathing.
 - 3. Anchors: Expansion shield and lag bolt type for anchorage to solid masonry or concrete.
- B. Die-Stamped Connectors: Hot dipped galvanized steel, sized to suit framing conditions.
 - 1. For contact with preservative treated wood in exposed locations, provide minimum G185 galvanizing complying with ASTM A653/A653M.
- C. Joist Hangers: Hot dipped galvanized steel, sized to suit framing conditions.
 - 1. For contact with preservative treated wood in exposed locations, provide minimum G185 galvanizing complying with ASTM A653/A653M.
- D. Sill Gasket on Top of Foundation Wall: 3/8 inch thick, plate width, closed cell plastic foam from continuous rolls.
 - 1. Self-adhered.
 - 2. Products:
 - a. Protecto Wrap; Protecto Premium Energy Sill Sealer
 - b. Substitutions: See Section 01 6000 - Product Requirements.
- E. Sill Flashing: See Section 07 6200.
- F. Subfloor Adhesives: Gap-filling construction adhesive for bonding wood structural panels to wood-based floor system framing; complying with ASTM D3498.
- G. General Purpose Construction Adhesives: Comply with ASTM C557.
- H. Water-Resistive Barrier: See Section 07 2500.

2.07 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.

1. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.
- B. Preservative Treatment (PT):
 1. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber in contact with roofing, flashing, or waterproofing.
 - c. Treat lumber in contact with masonry or concrete.
 - d. Treat lumber less than 6 inches above grade.
 - e. Treat lumber in other locations as indicated.
 2. Preservative Pressure Treatment of Plywood Above Grade: AWPA U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
 - a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 - b. Treat plywood in contact with roofing, flashing, or waterproofing.
 - c. Treat plywood in contact with masonry or concrete.
 - d. Treat plywood less than 18 inches above grade.
 - e. Treat plywood in other locations as indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Install sill gasket under sill plate of framed walls bearing on foundations; puncture gasket cleanly to fit tightly around protruding anchor bolts.

3.02 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 FRAMING INSTALLATION

- A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.
- B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
- C. Install structural members full length without splices unless otherwise specifically detailed.
- D. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes and AWC (WFCM) Wood Frame Construction Manual.
- E. Install horizontal spanning members with crown edge up and not less than 1-1/2 inches of bearing at each end.
- F. Construct double joist headers at floor and ceiling openings and under wall stud partitions that are parallel to floor joists; use metal joist hangers unless otherwise detailed.
- G. Provide bridging at joists in excess of 8 feet span as detailed. Fit solid blocking at ends of members.
- H. Frame wall openings with two or more studs at each jamb; support headers on cripple studs.
- I. Where top of wall plate meets roof framing and roof deck, provide deflection gap with deflection clips. At roof framing, provide deflection clip at each framing member. At roof deck, provide deflection clip at 16 inches maximum on center, aligned with studs.

3.04 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- C. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- D. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- E. Provide the following specific nonstructural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Wall brackets.
 - 3. Handrails.
 - 4. Grab bars.
 - 5. Towel and bath accessories.
 - 6. Wall-mounted door stops.
 - 7. Chalkboards and marker boards.
 - 8. Wall paneling and trim.
 - 9. Joints of rigid wall coverings that occur between studs.
 - 10. Magnetic hold opens.
 - 11. TV, projectors, projections screens
 - 12. Fire extinguishers and cabinets.
 - 13. Toilet partitions.
 - 14. Acoustic panels and components.
 - 15. Other items indicated on drawings that require mounting to walls and/or ceilings/soffits.

3.05 INSTALLATION OF CONSTRUCTION PANELS

- A. Subflooring: Glue and nail to framing; staples are not permitted.
- B. Roof Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.
 - 1. At long edges provide solid edge blocking where joints occur between roof framing members.
 - 2. Nail panels to framing; staples are not permitted.
- C. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 3. Install adjacent boards without gaps.

3.06 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.
- B. Variation from Plane, Other than Floors: 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.07 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.

3.08 CLEANING

- A. Waste Disposal: See Section 01 7419 - Construction Waste Management and Disposal.
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 06 1000

SECTION 06 2000
FINISH CARPENTRY

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Finish carpentry items.
- B. Wood door frames, glazed frames.
- C. Wood casings and moldings.
- D. Hardware and attachment accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 09 9123 - Interior Painting: Painting of finish carpentry items.

1.03 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. See Section 01 3323 - Shop Drawings, Product Data, Samples
- C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Provide the information required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store finish carpentry items under cover, elevated above grade, and in a dry, well-ventilated area not exposed to heat or sunlight.
- B. Protect from moisture damage.

PART 2 PRODUCTS**2.01 FINISH CARPENTRY ITEMS**

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Exterior Woodwork Items:
 - 1. Window Casings and Moldings: Softwood; prepare for paint finish.
- C. Interior Woodwork Items:
 - 1. Wood framed relites.(WD-1)
 - a. Species: Maple. Clear finish.
 - 2. Window Sills: (WD-1)
 - a. Species: Poplar or Fir. Painted.
 - 3. Corridor "Tree" shelving (WD-1)
 - a. Species: Maple, Clear finish.
 - 4. Classroom "Trees". (WD-2)
 - a. Species: Douglas Fir. Clear finish.
 - 5. Wall Caps: (WD-1)
 - a. Species: Maple. Clear finish.

2.02 LUMBER MATERIALS

- A. Douglas-Fir, clear, plain sliced.

- B. Hardwood Lumber: ____ species, ____ sawn, maximum moisture content of 6 percent , of quality suitable for transparent finish.

2.03 SITE FINISHING MATERIALS

- A. Finishing: Field finished as specified in Section 09 9123.

2.04 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.
- B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

2.05 SHOP FINISHING

- A. Sand work smooth and set exposed nails and screws.
- B. Apply wood filler in exposed nail and screw indentations.
- C. On items to receive transparent finishes, use wood filler that matches surrounding surfaces and is of type recommended for the applicable finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION

- A. Install custom fabrications in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.

3.03 PREPARATION FOR SITE FINISHING

- A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
- B. Site Finishing: See Section 09 9123.

END OF SECTION 06 2000

SECTION 06 4100
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Specially fabricated cabinet units.
- B. Hardware.
- C. Factory finishing.
- D. Preparation for installing utilities.

1.02 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- C. BHMA A156.9 - American National Standard for Cabinet Hardware; 2015.
- D. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2020.
- E. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- F. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 SUBMITTALS

- A. See Section 01 3323 - Shop Drawings, Product Data, Samples
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
- C. Product Data: Provide data for hardware accessories.

1.04 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from moisture damage.

1.06 FIELD CONDITIONS

- A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS**2.01 CABINETS**

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Wood Veneer Faced Cabinet:
 - 1. Exposed Surfaces: HPVA HP-1 Grade A, Maple, plain sliced, random-matched.
 - 2. Semi-Exposed Surfaces: HPVA HP-1 Grade B, Maple, plain sliced, random-matched.
 - 3. Concealed Surfaces: Manufacturer's option.
- C. Plastic Laminate Faced Cabinets: Custom grade.
 - 1. Product and Color: See Finish Schedule
- D. Cabinets:
 - 1. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
 - 2. Cabinet Style: Flush overlay.
 - 3. Cabinet Doors and Drawer Fronts: Flush style.

2.02 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.

2.03 LAMINATE MATERIALS

- A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.
- B. Provide specific types as indicated.

2.04 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. Plastic Edge Banding: Extruded PVC, flat shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
 - 1. Color: As selected by Architect from manufacturer's full range.
- C. Fasteners: Size and type to suit application.
- D. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- E. Concealed Joint Fasteners: Threaded steel.
- F. Grommets: Standard plastic, painted metal, or rubber grommets for cut-outs, in color to match adjacent surface.

2.05 HARDWARE

- A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
- B. Metal Z-Shaped Wall Cabinet Support Clips: Paired, cleated, structural anchorage components applied to back of cabinets and walls for wall cabinet mounting.
- C. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.
- D. Fixed Standard Shelf, Countertop, and Workstation Brackets:
 - 1. Material: Steel.
 - 2. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 - 3. Color: Black.
- E. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers.
- F. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish.
- G. Drawer Slides:
 - 1. Type: Full extension.
 - 2. Static Load Capacity: Commercial grade.
 - 3. Mounting: Side mounted.
 - 4. Stops: Integral type.
 - 5. Features: Provide self closing/stay closed type.
- H. Hinges: European style concealed self-closing type, steel with nickel-plated finish.
- I. Soft Close Adapter: Concealed, frame-mounted, screw-adjustable damper; steel with polished finish.

2.06 SHOP TREATMENT OF WOOD MATERIALS

- A. Provide UL (DIR) listed and approved identification on fire retardant treated material.
- B. Deliver fire retardant treated materials cut to required sizes. Minimize field cutting.

2.07 SITE FINISHING MATERIALS**2.08 FABRICATION**

- A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

- B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
- E. Matching Wood Grain: Comply with requirements of quality standard for specified Grade and as follows:
 - 1. Provide sequence matching across each elevation.
- F. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

2.09 SHOP FINISHING

- A. Sand work smooth and set exposed nails and screws.
- B. On items to receive transparent finishes, use wood filler matching or blending with surrounding surfaces and of types recommended for applied finishes.
- C. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:

PART 3 EXECUTION

3.01 INSTALLATION

- A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- B. Use fixture attachments in concealed locations for wall mounted components.
- C. Use concealed joint fasteners to align and secure adjoining cabinet units.
- D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
- E. Secure cabinets to floor using appropriate angles and anchorages.
- F. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.02 ADJUSTING

- A. Adjust installed work.
- B. Adjust moving or operating parts to function smoothly and correctly.

3.03 CLEANING

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 06 4100

**SECTION 07 2100
THERMAL INSULATION**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Batt insulation in exterior wall, ceiling, and floor construction.
- B. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 RELATED REQUIREMENTS

- A. Section 07 2119 - Foamed-in-Place Insulation.
- B. Section 07 2126 - Blown Insulation.
- C. Section 07 5400 - Thermoplastic Membrane Roofing: Low-slope roofing insulation.

1.03 DEFINITIONS

- A. Mineral Fiber Material Composition: Insulation referred to as mineral fiber block, board, and blanket insulation is composed of fibers from mineral based substances such as rock, slag, or glass and processed from the molten state into fibrous form.
 - 1. Based on type of insulation substance, the material will be referred to as a mineral fiber when having a rock or slag base, and glass fiber with a glass or silica sand base, also considered a mineral.
 - 2. Insulation blankets are flexible units consisting of felted, bonded, or unbonded fibers formed into rolls or flat cut pieces referred to as batts; rolls are simply longer versions of batts.
 - 3. For additional information about mineral fiber and the various classification types, refer to the following reference standards; ASTM C553, ASTM C612, ASTM C665, and ASTM C726.

1.04 REFERENCE STANDARDS

- A. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- B. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2019.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- D. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2017.
- E. ASTM C726 - Standard Specification for Mineral Wool Roof Insulation Board; 2017.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- G. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C; 2019a.
- H. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2023.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

PART 2 PRODUCTS**2.01 GENERAL**

- A. Products to be formaldehyde-free.

2.02 APPLICATIONS

- A. Insulation in Wood Framed Walls: Batt insulation with paint vapor retarder.
- B. Insulation in Wood Framed Ceiling Structure: Batt insulation with no vapor retarder.
- C. Acoustic Interior Wall insulation: Batt insulation.

2.03 FOAM BOARD INSULATION MATERIALS

- A. Extruded Polystyrene (XPS) Board Insulation: Comply with ASTM C578 with either natural skin or cut cell surfaces.
 - 1. Type and Compressive Resistance: Type IV, 25 psi (173 kPa), minimum.
 - 2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
 - 3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
 - 4. Type and Thermal Resistance, R-value: Type IV, 5.0 (0.88), minimum, per 1 inch thickness at 75 degrees F mean temperature.
 - 5. Complies with fire resistance requirements indicated on drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
 - 6. Board Edges: Square.
 - 7. Products:
 - a. Carlisle Insulfoam; R-Tech IV Insulation.
 - b. DuPont de Nemours, Inc; Styrofoam Brand.
 - c. Kingspan Insulation LL; GreenGuard XPS.
 - d. Owens Corning Corporation; FOAMULAR XPS.
 - e. Substitutions: See Section 01 6000 - Product Requirements.

2.04 MINERAL FIBER BLANKET INSULATION MATERIALS

- A. Flexible Glass Fiber Blanket Thermal Insulation: Preformed insulation, complying with ASTM C665; friction fit.
 - 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 50 or less, when tested in accordance with ASTM E84.
 - 3. Combustibility: Non-combustible, when tested in accordance with ASTM E136.
 - 4. Formaldehyde Content: Zero.
 - 5. Thermal Resistance: R-value of 21, minimum, for 6" nominal stud walls.
 - 6. Thickness: Full Cavity.
 - 7. Facing: Unfaced.
 - 8. Products:
 - a. CertainTeed Corporation; High-Performance Fiber Glass Building Insulation.
 - b. Johns Manville; Formaldehyde-Free Fiberglass Insulation.
 - c. Owens Corning Corporation; PINK Next Gen Fiberglass Batt Insulation
- B. Mineral Wool Blanket Thermal Insulation: Flexible or semi-rigid preformed insulation, complying with ASTM C665.
 - 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.
 - 3. Thermal Resistance: R-value of 21, at 5-1/2 inch framed walls.
 - 4. Thickness: Full Cavity.
 - 5. Products:
 - a. Johns Manville; MinWool Sound Attenuation Fire Batts.
 - b. Knauf Insulation; EcoBatt Insulation.
 - c. ROCKWOOL; COMFORTBAT, or AFB evo.

- d. Thermafiber, Inc; SAFB FF.

2.05 ACCESSORIES

- A. Paint Vapor Retarder: See Section 09 9123 - Int
- B. Tape: Reinforced polyethylene film with acrylic pressure sensitive adhesive.
 - 1. Application: Sealing of interior circular penetrations, such as pipes or cables.
 - 2. Width: Are required for application.
- C. Sill Plate Sealer Gasket: See Section 06 1000 - Rough Carpentry.
- D. Nails or Staples: Steel wire; electroplated or galvanized; type and size to suit application.
- E. Adhesive: Type recommended by insulation manufacturer for application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION UNDER CONCRETE SLABS

- A. Place insulation under slabs on grade after base for slab has been compacted.
- B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
- C. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.

3.03 BATT INSTALLATION

- A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
- B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.

3.05 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 07 2100

SECTION 07 2119
FOAMED-IN-PLACE INSULATION

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Foamed-in-place insulation.

1.02 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- B. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2020.
- C. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2019.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023.
- E. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- F. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.
- C. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.
- D. Installer Qualification: Submit documentation of current contractor accreditation and current installer certification. Keep copies of all contractor accreditation and installer certification on site during and after installation. Present on-site documentation upon request.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified, with minimum three years documented experience, and approved by manufacturer.

1.05 FIELD CONDITIONS

- A. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.
- B. Do not apply foam when temperature is within 5 degrees F of dew point.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Foamed-In-Place Insulation: Medium-density, rigid or semi-rigid, open or closed cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
 - 1. Thermal Resistance: R-value of 5.0, minimum, per 1 inch thickness at 75 degrees F mean temperature when tested in accordance with ASTM C518.
 - 2. Water Vapor Permeance: Vapor retarder; 2 perms, maximum, when tested at intended thickness in accordance with ASTM E96/E96M, desiccant method.
 - 3. Water Absorption: Less than 2 percent by volume, maximum, when tested in accordance with ASTM D2842.
 - 4. Air Permeance: 0.04 cfm per square foot, maximum, when tested at intended thickness in accordance with ASTM E2178 at 1.57 psf.
 - 5. Closed Cell Content: At least 90 percent.

6. Density: 2.0 lbs/cu ft, nominal, in accordance with ASTM D1622.
7. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
8. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ACCESSORIES

- A. Primer: As required by insulation manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify work within construction spaces or crevices is complete prior to insulation application.
- B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation or overcoat adhesion.

3.02 PREPARATION

- A. Mask and protect adjacent surfaces from over spray or dusting.
- B. Apply primer in accordance with manufacturer's instructions.

3.03 APPLICATION

- A. Apply insulation in accordance with manufacturer's instructions.
- B. Apply insulation by spray method, to a uniform monolithic density without voids.
- C. Apply to a minimum cured thickness of 3 inches, or as indicated.
- D. Apply protective coating monolithically, without voids, to fully cover foam insulation, to achieve fire rating required.
- E. Patch damaged areas.
- F. Where applied to voids and gaps assure space for expansion to avoid pressure on adjacent materials that may bind operable parts.
- G. Trim excess away for applied trim or remove as required for continuous sealant bead.

3.04 PROTECTION

- A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION 07 2119

SECTION 07 2530
WRB - MECHANICALLY FASTENED; TYVEK

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Section Includes:
1. Commercial weather barrier assemblies.
 2. Flexible flashing.
 3. Weather barrier flashing.
 4. Fluid-applied flashing.
 5. Weather barrier accessories.
 6. Drainage material.

1.02 DEFINITIONS

- A. Weather Barrier: A combination of materials and accessories that do the following:
1. Prevent the accumulation of water as a water-resistive barrier.
 2. Minimize the air leakage into or out of the building envelope as a continuous air barrier.
 3. Provide sufficient water vapor transmission to enable drying as a vapor-permeable membrane.
- B. Water-Resistive Barrier: A combination of materials and accessories that prevent the accumulation of water within the wall assembly per International Building Code Section 1403.2.
- C. Continuous Air Barrier: The combination of interconnected materials, assemblies, and sealed joints and components of the building envelope that minimize air leakage into or out of the building envelope per ASHRAE 90.1 section 5.4.3.1.
- D. Vapor Diffusion: A slow movement of individual water vapor molecules from regions of higher to lower water vapor concentration (higher to lower vapor pressure).
- E. Vapor Permeable Membrane: The property of having a water-vapor permeance rating of 10 perms (575 ng/Pa x s x sq. m) or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E96 per definition in International Building Code. Vapor permeable material permits the passage of moisture vapor through vapor diffusion.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference:
1. Meet with Owner, Architect, Manufacturer's Certified Installer, [weather barrier manufacturer's designated field representative,] and installers of work that interfaces with or affects weather barrier.
 2. Review methods and procedures related to weather barrier installation, including manufacturer's written instructions.
 3. Review and finalize construction, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Examine substrate conditions and finishes for compliance with requirements.
 5. Review flashings, special weather barrier details, weather barrier penetrations, and condition of other construction that affects weather barrier.
 6. Review weather barrier manufacturer's Project Registration and Observation process.
 7. Review Construction Indoor Air Quality Management Plan "Moisture Protection for Absorbent Materials."
 8. Review temporary protection requirements for weather barrier during and after installation.

1.04 SUBMITTALS

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

1. For weather barrier, include data on air and water-vapor permeance based on testing in accordance with referenced standards.
- B. Shop Drawings: Show details of weather barrier at terminations, openings, and penetrations. Show details of flexible flashing applications.
- C. Evaluation Reports: For weather barrier and flexible flashing, from ICC-ES.
- D. Manufacturer's Instructions: For installation of each product specified.
- E. Qualification Data: For Installer [and] [laboratory mockup testing agency] [field testing agency].
- F. Sample Warranty: For manufacturer's warranty.
- G. Reports: Field test and inspection reports.
- H. Installer's weather barrier manufacturer-training certificate.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is certified by weather barrier system manufacturer to install manufacturer's product.
- B. Mockups: Build mockups to set quality standards for materials and execution.
 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Do not store near heat source or open flame.

1.07 WARRANTY

- A. Manufacturer's Product Warranty: To repair or replace weather barrier product that fails in materials within specified warranty period.
 1. Warranty Period: 10 years from date of purchase.
- B. Manufacturer's Product and Labor Warranty: Manufacturer agrees to repair or replace weather barrier that fails in materials within specified warranty period, including removal and replacement of affected construction up to manufacturer's limits.
 1. Warranty Period: [10 years from date of purchase] [or] [15 years from date of purchase].

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain weather barrier assembly components, including weather barrier flashing and foam insulation from same manufacturer as weather barrier or manufacturer approved by weather barrier manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed weather barrier and accessories shall withstand specified wind pressures, liquid water penetration, and water vapor pressures without failure due to defective manufacture of products.
- B. High-Performance Installations:
 1. For installation with one of the following building envelope performance or structural characteristics:
 - a. Exceeding 65 mph (100 km/h) equivalent structural load.
 - b. Exceeding 50 mph/6.24 psf (80 km/h) equivalent wind-driven rainwater infiltration.
 - c. Buildings of 85 ft. (26 m) or more total height above grade plane, as defined in the International Building Code.
 - d. Construction with gypsum or cement-based exterior sheathing.

- e. Non-wood based primary structure such as steel, light gauge steel, masonry, or concrete
- f. Wood based primary structure with performance criteria meeting criteria a, b and/or c above

2.03 WEATHER BARRIER

- A. Commercial Building Wrap: ASTM E2357 passed, ABAA (Air Barrier Association of America) evaluated air barrier assembly, and assembly water resistance per ASTM E331; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E84; UV stabilized for nine-month exposure; and acceptable to authorities having jurisdiction.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide DuPont de Nemours, Inc.; Tyvek CommercialWrap.
 - 2. Air Permeance, Product: Not more than 0.001 cfm/sq. ft. at 1.57 lbf/sq. ft. when tested in accordance with ASTM E2178.
 - 3. Water Penetration Resistance, Product: Hydrostatic head resistance greater than 22 inches (55 cm) in accordance with AATCC 127.
 - 4. Water-Vapor Permeance: Not less than 23 perms (1300 ng/Pa x s x sq. m) per ASTM E96/E96M, Desiccant Method (Procedure A) or not less than 28 perms (1600 ng/Pa x s x sq. m) per ASTM E96/E96M, Water Method (Procedure B).
 - 5. Water-Vapor Permeance: Not less than 30 perms (1700 ng/Pa x s x sq. m) per ASTM E96/E96M, Water Method (Procedure B).
 - 6. Allowable UV Exposure Time: Not less than 9 months (270 days) when tested in accordance with ASTM G155 (Accelerated Weathering).
 - 7. Flame Propagation Test: Materials and construction shall be as tested in accordance with NFPA 285.
 - 8. Heat and Visible Smoke Release Rates: Maximum rates in accordance with NFPA 285.
 - a. Peak Heat Release: 13,217 Btu/sq. ft. (150 kW/sq. m).
 - b. Total Heat Release: 1762 Btu/sq. ft. (20 MJ/sq. m).
 - c. Effective Heat of Combustion: 7744 Btu/lb (18 MJ/kg).
 - 9. Weather barrier system to have a VOC content of 30 g/L or less.

2.04 WEATHER BARRIER FLASHING

- A. Conformable Weather Barrier Flashing: Composite flashing material composed of micro-creped, polyethylene laminate with a 100 percent butyl-based adhesive layer; AAMA 711 Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for seven days.
 - 1. Basis-of-Design Product: DuPont™ FlexWrap.
 - 2. Conformability: Able to create a seamless sill pan extending up the jambs without cuts, patches, or fasteners.
 - 3. Water Penetration: No leakage at 15 psf (720 Pa) per ASTM E331.
 - 4. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 deg F (minus 4 deg C) as Class A (without primer use).
 - 5. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.
- B. Conformable Weather Barrier Flashing for Sealing Penetrations: Composite flashing material composed of micro-creped, polyethylene laminate with a 100 percent butyl-based adhesive layer; AAMA 711 Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for 7 days.
 - 1. Basis-of-Design Product: DuPont™ FlexWrap EZ.
 - 2. Conformability: Able to create a continuous watertight seal around penetrations from weather barrier to penetration without cuts, patches, or fasteners.

3. Water Penetration: No leakage at 15 psf (720 Pa) per ASTM E 331.
 4. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 degrees F (minus 4 deg C) as Class A (without primer use).
 5. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.
- C. Strip Flashing: Composite flashing material composed of spunbonded polyethylene laminate with 100 percent butyl-based, dual-sided, adhesive layer; AAMA 711, Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for seven days.
1. Basis-of-Design Product: DuPont StraightFlash
 2. Water Penetration: No leakage at 15 psf (720 Pa) per ASTM E331.
 3. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 deg F (minus 4 deg C) as Class A without primer use.
 4. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.
- D. Strip Flashing: Composite flashing material composed of spunbonded polyethylene laminate with 100 percent butyl-based, dual-sided, adhesive layer; AAMA 711, Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for 7 days.
1. Basis-of-Design Product: DuPont VersaFlange.
 2. Water Penetration: No leakage at 6.24 psf (300 Pa) per ASTM E 331.
 3. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 deg F (minus 4 deg C) as Class A without primer use.
 4. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.
- E. Strip Flashing: Composite flashing material composed of polypropylene laminate with 100 percent butyl-based, adhesive layer; AAMA 711, Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for 7 days.
1. Basis-of-Design Product: DuPont Flashing Tape.
 2. Water Penetration: No leakage at 6.24 psf (300 Pa) per ASTM E 331.
 3. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 deg F (minus 4 deg C) as Class A without primer use.
 4. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.

2.05 FLUID-APPLIED FLASHING

- A. Fluid-Applied Flashing: Trowel or brush applied, non-water soluble, single component, silyl terminated polyether technology (STPE), vapor permeable, flashing material.
1. Basis-of-Design Product: Tyvek Fluid Applied Flashing & Joint Compound+.
 2. VOC Content: ASTM C1250, less than 2 percent by weight and between 25 to 30 g/L.
 3. Water Vapor Transmission: ASTM E96, Method B, greater than 20 perms (1100 ng/Pa x s x sq. m) at 25 mils (0.635 mm) thick.
 4. Minimum Tensile Strength: ASTM D412, 165 lb/sq. ft. (1140 kPa).
 5. Minimum Elongation at Break: ASTM D412; 380 percent.

2.06 WEATHER BARRIER ACCESSORIES

- A. Building Wrap Tape: Pressure-sensitive plastic tape recommended by weather barrier manufacturer for sealing joints and penetrations in commercial building wrap.
1. Basis-of-Design Product: Tyvek® Tape.
- B. Closed-Cell Polyurethane Foam Insulation: Low-pressure, low-expansion, single-component polyurethane foam, with maximum flame-spread and smoke-developed indexes of 15 and 25, respectively, per ASTM E84.
1. Basis-of-Design Product: DuPont™ Great Stuff Pro.

- C. Fasteners with Self-Gasketing Washers: Commercial building wrap manufacturer's recommended pneumatically or hand-applied fasteners with [1-inch- (25-mm)] [2-inch- (50-mm-)] diameter, high-density polyethylene cap washers with UV inhibitors.
 - 1. Basis-of-Design Product: Tyvek® Wrap Caps.
- D. Primer for Flashings: Synthetic rubber-based product; spray applied. Strengthen adhesive bond at low temperature applications between weather products such as self-adhered flashing products, commercial building wraps, and common building sheathing materials.
 - 1. Peel Adhesion Test: Passes in accordance with ASTM D3330, Test Method F, for the following.
 - a. Peel Angles: 0, 25, 72, and 180 degrees.
 - b. Substrates: Concrete masonry units (CMUs), exterior gypsum sheathing, oriented strand board (OSB), aluminum, and vinyl.
 - 2. Chemical Compatibility: Pass; AAMA 713.
 - 3. Flame Spread Index: 5; ASTM E84.
 - 4. Smoke Development Index: 0; ASTM E84.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements.
- B. Verify that substrate and surface conditions are in accordance with commercial weather barrier manufacturer recommendations prior to installation.
 - 1. Verify that rough sill framing for doors and windows is sloped downwards towards the exterior and is level across width of the opening.
- C. Verify that surfaces to receive weather barrier flashing are clean, dry, and free of frost.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Direct water onto an acceptable weather barrier drainage plane with an unobstructed path to exterior of wall.
 - 1. Provide a drainage path for water intrusion through window and door attachment system that collects at window and door sills and directs water to the exterior or weather barrier.

3.03 COMMERCIAL BUILDING WRAP INSTALLATION

- A. General: Comply with weather barrier manufacturer's written installation guidelines and warranty requirements.
- B. Cover exposed exterior surface of sheathing with weather barrier securely fastened to framing immediately after sheathing is installed.
 - 1. Maintain continuity of air and water barrier assemblies.
 - 2. Start weather barrier installation at a building corner, leaving 12 inches (300 mm) of weather barrier extended beyond corner to overlap.
 - 3. Install weather barrier horizontally starting at lower portion of wall surface.
 - 4. Provide minimum 6 inches (150 mm) overlap at horizontal- and vertical-wrap seams in a shingle manner to maintain continuous downward drainage plane and air and water barrier.
- C. Seams: Seal seams with building wrap tape per manufacturer's recommended installation instructions.
 - 1. Shiplap horizontal seams in weather barrier to facilitate proper drainage.
- D. Fasteners: Use weather barrier manufacturer's recommended fasteners to secure weather barrier and install fasteners according to weather barrier manufacturer's installation guidelines.
 - 1. Do not use temporary fasteners to permanently attach weather barrier.
 - 2. Do not place fasteners with gasketing washers where weather barrier flashing will be installed.

3. Install fasteners with gasketing washers through flashing where recommended by manufacturer.
- E. Openings: Completely cover openings with weather barrier, then cut weather barrier membrane to openings in accordance with weather barrier manufacturer's installation guidelines.
 1. Provide head and jamb flaps and seam overlaps to maintain continuous drainage.
 2. Repair damage to weather barrier using method recommended by weather barrier manufacturer.
 3. Install flashing in accordance with weather barrier manufacturer's installation guidelines.

3.04 WEATHER BARRIER FLASHING INSTALLATION

- A. Installation: Remove wrinkles and bubbles, reposition weather barrier as necessary to produce a uniform, smooth surface.
 1. Ensure that ambient and substrate surface temperatures are acceptable in accordance with manufacturer instructions and recommendations.
 2. Wipe surfaces to remove moisture, dirt, grease and other debris that could interfere with adhesion.
 3. Apply weather barrier manufacturer's recommended primer over concrete, masonry, and glass-mat gypsum wall sheathing substrates to receive weather barrier flashing.
 4. Lap weather barrier flashing a minimum of 2 inches (50 mm) onto weather barrier.
 5. Apply pressure over entire surface using roller or firm hand pressure
- B. Rough Openings: Shiplap flashing with weather barrier in a shingle manner to maintain a continuous downward drainage plane and air and water barrier in accordance with manufacturer's written instructions.
 1. Apply [6-inch- (150-mm-)] [9-inch- (230-mm-)] wide conformable weather barrier flashing at door and window sills.
 2. Ensure that sill flashing does not slope to the interior.
 3. Install backer rod in joint between frame of opening product and flashed rough opening on the interior.
 4. Apply sealant or closed-cell polyurethane foam insulation around entire opening/fenestration product to create air seal around interior perimeter of window openings in accordance with weather barrier manufacturer's instructions.
 5. Around door and window openings, apply butyl-based flashing to flaps of weather barrier.
 6. Use strip flashing with wrap cap screws to secure head flap of the windows.
- C. Penetrations: Apply weather barrier manufacturer's recommended weather barrier flashing patches behind fastening plates, such as brick-tie base plates, metal-flashing clips, and metal channels.
 1. Seal weather barrier around each penetration with weather barrier manufacturer's recommended self-adhered flashing product or sealant. Integrate products with flanges into the weather barrier.
- D. Terminations: Provide minimum 2 inches (50 mm) overlap using strip flashing on adjoining roof and base of wall systems to maintain continuous downward drainage plane.
 1. Secure weather barrier with fasteners and weather barrier flashing.

3.05 FLUID-APPLIED FLASHING INSTALLATION

- A. General: Before installing fluid-applied flashing, do the following:
 1. Ensure drainage path is not blocked or disrupted. Do not install on walls that do not feature a continuous path for moisture drainage. Blocked or disrupted paths for drainage can result in excess moisture buildup in wall cavity. Do not install below grade.
 2. Remove surface dust, dirt, and loose mortar.
 3. Verify that surface is free of grease and other contaminants and that surface is smooth.

4. Fill joints in CMUs and voids in cast-in-place concrete with trowel-applied fluid-applied flashing to ensure surface is flush and smooth.
 5. Allow masonry mortar and cast-in-place concrete a minimum of 24 hours to cure before installing fluid-applied flashing.
- B. Fluid-Applied Flashing Installation: Using a trowel or brush, apply fluid-applied flashing around perimeter of recessed window and door openings to a minimum thickness of 25 mils (0.635 mm).
1. Extend flashing a minimum of 2 inches (50 mm) onto top of transition membrane.
 2. Inspect for gaps and pinholes in fluid-applied flashing and apply additional coats until no gaps and pinholes appear.
 3. Joint Applications: Using a trowel or a brush, fill cracks and voids up to 1/4 inch (6 mm) in width.
 - a. For joints and cracks between 1/4 and 1/2 inch (6 and 12 mm) wide, cover first with mesh tape.
 - b. For joints and cracks between 1/2 and 1 inch (12 and 24 mm) wide, cover first with butyl-based strip flashing.
 - c. Apply a bead, then trowel smooth.
 - d. Seam coverage should be a minimum of 2 inches (50 mm) wide and 15 to 20 mils (0.38 to 0.51 mm) thick.
 - e. Inspect for gaps and pinholes in fluid-applied flashing and apply additional coats until no gaps and pinholes appear.

3.06 DRAINAGE MATERIAL INSTALLATION

- A. Install drainage material with grooves or channels running vertically in compliance with manufacturer's written instructions.

3.07 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to train installers and observe subject test-wall areas and installations.
- B. Testing Agency: Owner will engage a qualified third-party testing agency to perform tests and inspections.
- C. Test Area: Perform tests on one bay at least 30 ft. (9.15 m), by one story representative areas of structural-sealant-glazed curtain walls.
- D. Test and Inspection Reports: Prepare test and inspection reports.

3.08 CLEANING

- A. Immediately remove release paper and scrap from work area and dispose of material in accordance with requirements of [Section 017300 "Execution."] [Section 017419 "Construction Waste Management and Disposal."] [Section 017300 "Execution" and Section 017419 "Construction Waste Management and Disposal."]

3.09 PROTECTION

- A. Protect installed weather barrier from the following:
 1. Damage from cladding, structure, or a component of the structure (for example, window, door, or wall system).
 2. Contamination from building site chemicals, premature deterioration of building materials, or nonstandard use or application of products.
 3. Foreign objects or agents, including the use of materials incompatible with weather barrier products.
 4. UV exposure in excess of products' stated limits.

END OF SECTION 07 2530

SECTION 07 2530
WRB - MECHANICALLY FASTENED; TYVEK

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Section Includes:
1. Commercial weather barrier assemblies.
 2. Flexible flashing.
 3. Weather barrier flashing.
 4. Fluid-applied flashing.
 5. Weather barrier accessories.
 6. Drainage material.

1.02 DEFINITIONS

- A. Weather Barrier: A combination of materials and accessories that do the following:
1. Prevent the accumulation of water as a water-resistive barrier.
 2. Minimize the air leakage into or out of the building envelope as a continuous air barrier.
 3. Provide sufficient water vapor transmission to enable drying as a vapor-permeable membrane.
- B. Water-Resistive Barrier: A combination of materials and accessories that prevent the accumulation of water within the wall assembly per International Building Code Section 1403.2.
- C. Continuous Air Barrier: The combination of interconnected materials, assemblies, and sealed joints and components of the building envelope that minimize air leakage into or out of the building envelope per ASHRAE 90.1 section 5.4.3.1.
- D. Vapor Diffusion: A slow movement of individual water vapor molecules from regions of higher to lower water vapor concentration (higher to lower vapor pressure).
- E. Vapor Permeable Membrane: The property of having a water-vapor permeance rating of 10 perms (575 ng/Pa x s x sq. m) or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E96 per definition in International Building Code. Vapor permeable material permits the passage of moisture vapor through vapor diffusion.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference:
1. Meet with Owner, Architect, Manufacturer's Certified Installer, [weather barrier manufacturer's designated field representative,] and installers of work that interfaces with or affects weather barrier.
 2. Review methods and procedures related to weather barrier installation, including manufacturer's written instructions.
 3. Review and finalize construction, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Examine substrate conditions and finishes for compliance with requirements.
 5. Review flashings, special weather barrier details, weather barrier penetrations, and condition of other construction that affects weather barrier.
 6. Review weather barrier manufacturer's Project Registration and Observation process.
 7. Review Construction Indoor Air Quality Management Plan "Moisture Protection for Absorbent Materials."
 8. Review temporary protection requirements for weather barrier during and after installation.

1.04 SUBMITTALS

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

1. For weather barrier, include data on air and water-vapor permeance based on testing in accordance with referenced standards.
- B. Shop Drawings: Show details of weather barrier at terminations, openings, and penetrations. Show details of flexible flashing applications.
- C. Evaluation Reports: For weather barrier and flexible flashing, from ICC-ES.
- D. Manufacturer's Instructions: For installation of each product specified.
- E. Qualification Data: For Installer [and] [laboratory mockup testing agency] [field testing agency].
- F. Sample Warranty: For manufacturer's warranty.
- G. Reports: Field test and inspection reports.
- H. Installer's weather barrier manufacturer-training certificate.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is certified by weather barrier system manufacturer to install manufacturer's product.
- B. Mockups: Build mockups to set quality standards for materials and execution.
 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Do not store near heat source or open flame.

1.07 WARRANTY

- A. Manufacturer's Product Warranty: To repair or replace weather barrier product that fails in materials within specified warranty period.
 1. Warranty Period: 10 years from date of purchase.
- B. Manufacturer's Product and Labor Warranty: Manufacturer agrees to repair or replace weather barrier that fails in materials within specified warranty period, including removal and replacement of affected construction up to manufacturer's limits.
 1. Warranty Period: [10 years from date of purchase] [or] [15 years from date of purchase].

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain weather barrier assembly components, including [weather barrier flashing] [and] [foam insulation] from [same manufacturer as weather barrier] [or] [manufacturer approved by weather barrier manufacturer].

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed weather barrier and accessories shall withstand specified wind pressures, liquid water penetration, and water vapor pressures without failure due to defective manufacture of products.
- B. High-Performance Installations:
 1. For installation with one of the following building envelope performance or structural characteristics:
 - a. Exceeding 65 mph (100 km/h) equivalent structural load.
 - b. Exceeding 50 mph/6.24 psf (80 km/h) equivalent wind-driven rainwater infiltration.
 - c. Buildings of 85 ft. (26 m) or more total height above grade plane, as defined in the International Building Code.
 - d. Construction with gypsum or cement-based exterior sheathing.

- e. Non-wood based primary structure such as steel, light gauge steel, masonry, or concrete
- f. Wood based primary structure with performance criteria meeting criteria a, b and/or c above

2.03 WEATHER BARRIER

- A. Commercial Building Wrap: ASTM E2357 passed, ABAA (Air Barrier Association of America) evaluated air barrier assembly, and assembly water resistance per ASTM E331; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E84; UV stabilized for nine-month exposure; and acceptable to authorities having jurisdiction.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide DuPont de Nemours, Inc.; Tyvek CommercialWrap.
 - 2. Air Permeance, Product: Not more than 0.001 cfm/sq. ft. at 1.57 lbf/sq. ft. when tested in accordance with ASTM E2178.
 - 3. Water Penetration Resistance, Product: Hydrostatic head resistance greater than 22 inches (55 cm) in accordance with AATCC 127.
 - 4. Water-Vapor Permeance: Not less than 23 perms (1300 ng/Pa x s x sq. m) per ASTM E96/E96M, Desiccant Method (Procedure A) or not less than 28 perms (1600 ng/Pa x s x sq. m) per ASTM E96/E96M, Water Method (Procedure B).
 - 5. Water-Vapor Permeance: Not less than 30 perms (1700 ng/Pa x s x sq. m) per ASTM E96/E96M, Water Method (Procedure B).
 - 6. Allowable UV Exposure Time: Not less than 9 months (270 days) when tested in accordance with ASTM G155 (Accelerated Weathering).
 - 7. Flame Propagation Test: Materials and construction shall be as tested in accordance with NFPA 285.
 - 8. Heat and Visible Smoke Release Rates: Maximum rates in accordance with NFPA 285.
 - a. Peak Heat Release: 13,217 Btu/sq. ft. (150 kW/sq. m).
 - b. Total Heat Release: 1762 Btu/sq. ft. (20 MJ/sq. m).
 - c. Effective Heat of Combustion: 7744 Btu/lb (18 MJ/kg).
 - 9. Weather barrier system to have a VOC content of 30 g/L or less.

2.04 WEATHER BARRIER FLASHING

- A. Conformable Weather Barrier Flashing: Composite flashing material composed of micro-creped, polyethylene laminate with a 100 percent butyl-based adhesive layer; AAMA 711 Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for seven days.
 - 1. Basis-of-Design Product: DuPont™ FlexWrap.
 - 2. Conformability: Able to create a seamless sill pan extending up the jambs without cuts, patches, or fasteners.
 - 3. Water Penetration: No leakage at 15 psf (720 Pa) per ASTM E331.
 - 4. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 deg F (minus 4 deg C) as Class A (without primer use).
 - 5. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.
- B. Conformable Weather Barrier Flashing for Sealing Penetrations: Composite flashing material composed of micro-creped, polyethylene laminate with a 100 percent butyl-based adhesive layer; AAMA 711 Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for 7 days.
 - 1. Basis-of-Design Product: DuPont™ FlexWrap EZ.
 - 2. Conformability: Able to create a continuous watertight seal around penetrations from weather barrier to penetration without cuts, patches, or fasteners.

3. Water Penetration: No leakage at 15 psf (720 Pa) per ASTM E 331.
 4. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 degrees F (minus 4 deg C) as Class A (without primer use).
 5. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.
- C. Strip Flashing: Composite flashing material composed of spunbonded polyethylene laminate with 100 percent butyl-based, dual-sided, adhesive layer; AAMA 711, Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for seven days.
1. Basis-of-Design Product: DuPont StraightFlash
 2. Water Penetration: No leakage at 15 psf (720 Pa) per ASTM E331.
 3. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 deg F (minus 4 deg C) as Class A without primer use.
 4. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.
- D. Strip Flashing: Composite flashing material composed of spunbonded polyethylene laminate with 100 percent butyl-based, dual-sided, adhesive layer; AAMA 711, Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for 7 days.
1. Basis-of-Design Product: DuPont VersaFlange.
 2. Water Penetration: No leakage at 6.24 psf (300 Pa) per ASTM E 331.
 3. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 deg F (minus 4 deg C) as Class A without primer use.
 4. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.
- E. Strip Flashing: Composite flashing material composed of polypropylene laminate with 100 percent butyl-based, adhesive layer; AAMA 711, Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for 7 days.
1. Basis-of-Design Product: DuPont Flashing Tape.
 2. Water Penetration: No leakage at 6.24 psf (300 Pa) per ASTM E 331.
 3. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 deg F (minus 4 deg C) as Class A without primer use.
 4. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.

2.05 FLUID-APPLIED FLASHING

- A. Fluid-Applied Flashing: Trowel or brush applied, non-water soluble, single component, silyl terminated polyether technology (STPE), vapor permeable, flashing material.
1. Basis-of-Design Product: Tyvek Fluid Applied Flashing & Joint Compound+.
 2. VOC Content: ASTM C1250, less than 2 percent by weight and between 25 to 30 g/L.
 3. Water Vapor Transmission: ASTM E96, Method B, greater than 20 perms (1100 ng/Pa x s x sq. m) at 25 mils (0.635 mm) thick.
 4. Minimum Tensile Strength: ASTM D412, 165 lb/sq. ft. (1140 kPa).
 5. Minimum Elongation at Break: ASTM D412; 380 percent.

2.06 WEATHER BARRIER ACCESSORIES

- A. Building Wrap Tape: Pressure-sensitive plastic tape recommended by weather barrier manufacturer for sealing joints and penetrations in commercial building wrap.
1. Basis-of-Design Product: Tyvek® Tape.
- B. Closed-Cell Polyurethane Foam Insulation: Low-pressure, low-expansion, single-component polyurethane foam, with maximum flame-spread and smoke-developed indexes of 15 and 25, respectively, per ASTM E84.
1. Basis-of-Design Product: DuPont™ Great Stuff Pro.

- C. Fasteners with Self-Gasketing Washers: Commercial building wrap manufacturer's recommended pneumatically or hand-applied fasteners with [1-inch- (25-mm)] [2-inch- (50-mm-)] diameter, high-density polyethylene cap washers with UV inhibitors.
 - 1. Basis-of-Design Product: Tyvek® Wrap Caps.
- D. Primer for Flashings: Synthetic rubber-based product; spray applied. Strengthen adhesive bond at low temperature applications between weather products such as self-adhered flashing products, commercial building wraps, and common building sheathing materials.
 - 1. Peel Adhesion Test: Passes in accordance with ASTM D3330, Test Method F, for the following.
 - a. Peel Angles: 0, 25, 72, and 180 degrees.
 - b. Substrates: Concrete masonry units (CMUs), exterior gypsum sheathing, oriented strand board (OSB), aluminum, and vinyl.
 - 2. Chemical Compatibility: Pass; AAMA 713.
 - 3. Flame Spread Index: 5; ASTM E84.
 - 4. Smoke Development Index: 0; ASTM E84.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements.
- B. Verify that substrate and surface conditions are in accordance with commercial weather barrier manufacturer recommendations prior to installation.
 - 1. Verify that rough sill framing for doors and windows is sloped downwards towards the exterior and is level across width of the opening.
- C. Verify that surfaces to receive weather barrier flashing are clean, dry, and free of frost.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Direct water onto an acceptable weather barrier drainage plane with an unobstructed path to exterior of wall.
 - 1. Provide a drainage path for water intrusion through window and door attachment system that collects at window and door sills and directs water to the exterior or weather barrier.

3.03 COMMERCIAL BUILDING WRAP INSTALLATION

- A. General: Comply with weather barrier manufacturer's written installation guidelines and warranty requirements.
- B. Cover exposed exterior surface of sheathing with weather barrier securely fastened to framing immediately after sheathing is installed.
 - 1. Maintain continuity of air and water barrier assemblies.
 - 2. Start weather barrier installation at a building corner, leaving 12 inches (300 mm) of weather barrier extended beyond corner to overlap.
 - 3. Install weather barrier horizontally starting at lower portion of wall surface.
 - 4. Provide minimum 6 inches (150 mm) overlap at horizontal- and vertical-wrap seams in a shingle manner to maintain continuous downward drainage plane and air and water barrier.
- C. Seams: Seal seams with building wrap tape per manufacturer's recommended installation instructions.
 - 1. Shiplap horizontal seams in weather barrier to facilitate proper drainage.
- D. Fasteners: Use weather barrier manufacturer's recommended fasteners to secure weather barrier and install fasteners according to weather barrier manufacturer's installation guidelines.
 - 1. Do not use temporary fasteners to permanently attach weather barrier.
 - 2. Do not place fasteners with gasketing washers where weather barrier flashing will be installed.

3. Install fasteners with gasketing washers through flashing where recommended by manufacturer.
- E. Openings: Completely cover openings with weather barrier, then cut weather barrier membrane to openings in accordance with weather barrier manufacturer's installation guidelines.
 1. Provide head and jamb flaps and seam overlaps to maintain continuous drainage.
 2. Repair damage to weather barrier using method recommended by weather barrier manufacturer.
 3. Install flashing in accordance with weather barrier manufacturer's installation guidelines.

3.04 WEATHER BARRIER FLASHING INSTALLATION

- A. Installation: Remove wrinkles and bubbles, reposition weather barrier as necessary to produce a uniform, smooth surface.
 1. Ensure that ambient and substrate surface temperatures are acceptable in accordance with manufacturer instructions and recommendations.
 2. Wipe surfaces to remove moisture, dirt, grease and other debris that could interfere with adhesion.
 3. Apply weather barrier manufacturer's recommended primer over concrete, masonry, and glass-mat gypsum wall sheathing substrates to receive weather barrier flashing.
 4. Lap weather barrier flashing a minimum of 2 inches (50 mm) onto weather barrier.
 5. Apply pressure over entire surface using roller or firm hand pressure
- B. Rough Openings: Shiplap flashing with weather barrier in a shingle manner to maintain a continuous downward drainage plane and air and water barrier in accordance with manufacturer's written instructions.
 1. Apply [6-inch- (150-mm-)] [9-inch- (230-mm-)] wide conformable weather barrier flashing at door and window sills.
 2. Ensure that sill flashing does not slope to the interior.
 3. Install backer rod in joint between frame of opening product and flashed rough opening on the interior.
 4. Apply sealant or closed-cell polyurethane foam insulation around entire opening/fenestration product to create air seal around interior perimeter of window openings in accordance with weather barrier manufacturer's instructions.
 5. Around door and window openings, apply butyl-based flashing to flaps of weather barrier.
 6. Use strip flashing with wrap cap screws to secure head flap of the windows.
- C. Penetrations: Apply weather barrier manufacturer's recommended weather barrier flashing patches behind fastening plates, such as brick-tie base plates, metal-flashing clips, and metal channels.
 1. Seal weather barrier around each penetration with weather barrier manufacturer's recommended self-adhered flashing product or sealant. Integrate products with flanges into the weather barrier.
- D. Terminations: Provide minimum 2 inches (50 mm) overlap using strip flashing on adjoining roof and base of wall systems to maintain continuous downward drainage plane.
 1. Secure weather barrier with fasteners and weather barrier flashing.

3.05 FLUID-APPLIED FLASHING INSTALLATION

- A. General: Before installing fluid-applied flashing, do the following:
 1. Ensure drainage path is not blocked or disrupted. Do not install on walls that do not feature a continuous path for moisture drainage. Blocked or disrupted paths for drainage can result in excess moisture buildup in wall cavity. Do not install below grade.
 2. Remove surface dust, dirt, and loose mortar.
 3. Verify that surface is free of grease and other contaminants and that surface is smooth.

4. Fill joints in CMUs and voids in cast-in-place concrete with trowel-applied fluid-applied flashing to ensure surface is flush and smooth.
 5. Allow masonry mortar and cast-in-place concrete a minimum of 24 hours to cure before installing fluid-applied flashing.
- B. Fluid-Applied Flashing Installation: Using a trowel or brush, apply fluid-applied flashing around perimeter of recessed window and door openings to a minimum thickness of 25 mils (0.635 mm).
1. Extend flashing a minimum of 2 inches (50 mm) onto top of transition membrane.
 2. Inspect for gaps and pinholes in fluid-applied flashing and apply additional coats until no gaps and pinholes appear.
 3. Joint Applications: Using a trowel or a brush, fill cracks and voids up to 1/4 inch (6 mm) in width.
 - a. For joints and cracks between 1/4 and 1/2 inch (6 and 12 mm) wide, cover first with mesh tape.
 - b. For joints and cracks between 1/2 and 1 inch (12 and 24 mm) wide, cover first with butyl-based strip flashing.
 - c. Apply a bead, then trowel smooth.
 - d. Seam coverage should be a minimum of 2 inches (50 mm) wide and 15 to 20 mils (0.38 to 0.51 mm) thick.
 - e. Inspect for gaps and pinholes in fluid-applied flashing and apply additional coats until no gaps and pinholes appear.

3.06 DRAINAGE MATERIAL INSTALLATION

- A. Install drainage material with grooves or channels running vertically in compliance with manufacturer's written instructions.

3.07 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to train installers and observe subject test-wall areas and installations.
- B. Testing Agency: [Owner will engage] [Engage] a qualified third-party testing agency to perform tests and inspections.
- C. Test Area: Perform tests on [one bay at least 30 ft. (9.15 m), by one story] [representative areas of structural-sealant-glazed curtain walls] [mockups] .
- D. Field Quality Control Testing: Perform the following test on [representative areas of structural-sealant-glazed curtain walls] [mockups] .
1. Air Infiltration Whole Building: ASTM E779 at not more than [0.40 cfm/sf (2.00 L/s per sq. m)] [0.25 cfm/sf (1.25 L/s per sq. m)] [0.15 cfm/sf (0.75 L/s per sq. m)] at 1.57 lb/sq. ft. (75 Pa).
 2. Water Penetration: ASTM E1105 at a minimum [uniform] [and] [cyclic] static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than [2.86 lbf/sq. ft. (137 Pa)] [6.24 lbf/sq. ft. (300 Pa)] [10.0 lbf/sq. ft. (500 Pa)] [12.5 lbf/sq. ft. (600 Pa)]. No water penetration shall occur as defined in ASTM E1105.
 - a. Perform a minimum of [two] [three] tests in areas as directed by Architect.
 - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to [10, 30, and 70 percent completion] .
- E. Test and Inspection Reports: Prepare test and inspection reports.

3.08 CLEANING

- A. Immediately remove release paper and scrap from work area and dispose of material in accordance with requirements of [Section 017300 "Execution."] [Section 017419 "Construction Waste Management and Disposal."] [Section 017300 "Execution" and Section 017419 "Construction Waste Management and Disposal."]

3.09 PROTECTION

- A. Protect installed weather barrier from the following:
1. Damage from cladding, structure, or a component of the structure (for example, window, door, or wall system).
 2. Contamination from building site chemicals, premature deterioration of building materials, or nonstandard use or application of products.
 3. Foreign objects or agents, including the use of materials incompatible with weather barrier products.
 4. UV exposure in excess of products' stated limits.

END OF SECTION 07 2530

SECTION 07 4113
METAL ROOF PANELS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Metal roof panel system of preformed steel panels.

1.02 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2023.
- C. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2021.
- D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a.
- E. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference; 2005 (Reapproved 2017).

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Summary of test results, indicating compliance with specified requirements.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Specimen warranty.
- C. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
 - 1. Show work to be field-fabricated or field-assembled.
 - 2. Include structural analysis signed and sealed by qualified structural engineer, indicating compliance of roofing system to specified loading conditions.
- D. Selection Samples: For each roofing system specified, submit color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each roofing system specified, submit samples of minimum size 12 inches square, representing actual roofing metal, thickness, profile, color, and texture.
 - 1. Include typical panel joint in sample.
 - 2. Include typical fastening detail.
- F. Test Reports: Indicate compliance of metal roofing system to specified requirements.
- G. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Provide strippable plastic protection on prefinished roofing panels for removal after installation.

1.06 FIELD CONDITIONS

- A. Do not install metal roof panels, eave protection membrane or underlayment when surface, ambient air, or wind chill temperatures are below 45 degrees F.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Finish Warranty: Provide 20-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.
- C. Special Warranty: Provide 5-year warranty for weathertightness of roofing system, including agreement to repair or replace metal roof panels that fail to keep out water commencing on the Date of Substantial Completion. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Architectural Metal Roof Panel Manufacturers:
 - 1. South and East Entry canopy, Basis of Design: Design Span hp Metal Roofing; by AEP Span.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

- A. Metal Roof Panels: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for compliance with the following minimum standards:
 - 1. Structural Design Criteria: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed L/180 of span length(L) when tested in accordance with ASTM E1592.
 - 2. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.
 - 3. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 100 degrees F.

2.03 METAL ROOF PANELS

- A. Metal Roof Panels: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.
- B. Metal Panels: Factory-formed panels with factory-applied finish.
 - 1. Steel Panels:
 - a. Aluminum-zinc alloy-coated steel complying with ASTM A792/A792M; minimum AZ50 coating.
 - b. Steel Thickness: Minimum: 22 gauge.
 - 2. Profile: Standing seam, with minimum 1-inch seam height; concealed fastener system for field seaming with special tool.
 - 3. Texture: Smooth.
 - 4. Width: Maximum panel coverage of 24 inches.

2.04 ATTACHMENT SYSTEM

- A. Concealed System: Provide manufacturer's standard stainless steel or nylon-coated aluminum concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.05 FINISHES

- A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch; color and gloss as selected by Architect from manufacturer's standard line.

2.06 ACCESSORIES

- A. Miscellaneous Sheet Metal Items: Provide flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, and equipment curbs of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
- B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish or combination steel and closed-cell foam.
- C. Sealants:
 - 1. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
 - 2. Concealed Sealant: Non-curing butyl sealant or tape sealant.
- D. Underlayment: Self-adhering polymer modified asphalt sheet complying with ASTM D1970/D1970M, with strippable release film and top surface of woven polypropylene sheet.
 - 1. Sheet Thickness: 22 mil, 0.022 inch minimum total thickness.
 - 2. Self Sealability: Nail sealability in accordance with ASTM D1970/D1970M.
 - 3. Low Temperature Flexibility: Comply with ASTM D1970/D1970M.
 - 4. Water Vapor Permeance: 0.1 perm, maximum, when tested in accordance with ASTM E96/E96M using Desiccant Method (Method A).
 - 5. Verify compatibility of underlayment with metal roofpanel manufacturer.
 - 6. Products:
 - a. Certaineed Roofing; WinterGuard HT - High Temperature Waterproofing Underlayment: www.certainteed.com/#sle.
 - b. Henry Company; Blueskin RF200: www.henry.com/#sle.
 - c. Henry Company; Blueskin PE200HT: www.henry.com/#sle.
 - d. Polyglass USA, Inc; Polystick MTS Self-Adhered High Temperature Roof Underlayment: www.polyglass.us/#sle.
 - e. System Components Corporation, Inc; FeITex SA300: www.systemcomponents.net/#sle.
 - f. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to ensure that completed roof will be free of leaks.
- B. Remove protective film from surface of roof panels immediately prior to installation; strip film carefully to avoid damage to prefinished surfaces.
- C. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by metal roof panel manufacturer.

- D. At locations where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.03 INSTALLATION

- A. Overall: Install roofing system in accordance with approved shop drawings and metal roof panel manufacturer's instructions and recommendations, as applicable to specific project conditions; securely anchor components of roofing system in place allowing for thermal and structural movement.
 - 1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.
 - 2. Minimize field cutting of panels. Where field cutting is required, use methods that will not distort panel profiles. Use of torches for field cutting is prohibited.
- B. Accessories: Install necessary components that are required for complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.
- C. Roof Panels: Install metal roof panels in accordance with manufacturer's installation instructions, minimizing transverse joints except at junction with penetrations.

3.04 CLEANING

- A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

3.05 PROTECTION

- A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.
- B. Touch-up, repair, or replace damaged roof panels or accessories before Date of Substantial Completion.

END OF SECTION 07 4113

SECTION 07 4646
FIBER-CEMENT SIDING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Fiber-cement siding, trims, and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Siding substrate.
- B. Section 07 2500 - Weather Resistive Barriers (WRB): Water-resistive barrier under siding.
- C. Section 07 9200 - Joint Sealants: Sealing joints between siding and adjacent construction and fixtures.
- D. Section 09 2116 - Gypsum Board Assemblies: Siding substrate.
- E. Section 09 9113 - Exterior Painting: Field painting.

1.03 REFERENCE STANDARDS

- A. ASTM C1186 - Standard Specification for Flat Fiber-Cement Sheets; 2022, with Editorial Revision (2023).

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
 - 1. Manufacturer's requirements for related materials to be installed by others.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation methods, including nail patterns.
- C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, and methods of anchorage.
- D. Installer's qualification statement.
- E. Warranty: Submit copy of manufacturer's warranty, made out in Owner's name, showing that it has been registered with manufacturer.
- F. Warranty Documentation for Installation of Building Rainscreen Assembly: Submit installer warranty and ensure that forms have been completed in Owner's name and registered with installer.
- G. Integrated Mock-Up: See Section 01 4000 - Quality Requirements and Delegated Design.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of type specified in this section with not less than three years of experience.

1.06 FIELD CONDITIONS

- A. Do not install panels when air temperature or relative humidity are outside manufacturer's limits.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.
- C. Manufacturer Warranty: Provide manufacturer warranty for years as indicated under Fiber-Cement Siding article sub-headings for "Warranty". Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS**2.01 FIBER-CEMENT SIDING**

- A. Manufacturer: James Hardie Building Products, Inc.
 - 1. Products for Climate Zone HZ10.
- B. Lap Siding: Individual horizontal boards made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C1186, Type A, Grade II; with machined edges, for nail attachment.
 - 1. Style: Standard lap style.
 - 2. Texture: Smooth.
 - 3. Length: 12 feet, nominal.
 - 4. Exposure (board size): as indicated on drawings.
 - 5. Finish: Factory applied primer.
 - 6. Warranty: 30 year limited; transferable.
- C. Soffit Panels: Smooth panels of same material and finish.

2.02 ACCESSORIES

- A. Furring Strips, wood: Pressure-treated plywood.
 - 1. Width: 3 inches.
 - 2. Thickness: 3/4 inch.
- B. Trim: Same material and texture as siding.
 - 1. Sizes as indicated in Drawings.
 - 2. Pre-primed, field painted.
- C. Fasteners: Galvanized or corrosion resistant; length as required to penetrate, 1-1/4 inches, minimum.
- D. Sealant: Elastomeric, polyurethane or silyl-terminated polyether/polyurethane, and capable of being painted.
- E. Finish Paint: Latex house paint acceptable to siding manufacturer; primer recommended by paint manufacturer.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Examine substrate, clean and repair as required to eliminate conditions that would be detrimental to proper installation.
- B. Do not begin until unacceptable conditions have been corrected.
- C. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Protect surrounding areas and adjacent surfaces during execution of this work.
- B. Install Sheet Metal Flashing:
 - 1. Above door and window trim and casings.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations.
 - 1. Read warranty and comply with terms necessary to maintain warranty coverage.
 - 2. Use trim details as indicated on drawings.
 - 3. Touch up field cut edges before installing.
 - 4. Pre-drill nail holes if necessary to prevent breakage.
- B. Over Wood and Wood-Composite Sheathing: Fasten siding through sheathing into studs.
- C. Allow space for thermal movement between both ends of siding panels that butt against trim; seal joint between panel and trim with specified sealant.

- D. Joints in Horizontal Siding: Avoid joints in lap siding except at corners; where joints are inevitable stagger joints between successive courses.
- E. Do not install siding less than 6 inches from ground surface, or closer than 1 inch to roofs, patios, porches, and other surfaces where water may collect.
- F. After installation, seal joints except lap joints of lap siding; seal around penetrations, and paint exposed cut edges.
- G. Finish Painting: See Section 09 9113.

3.04 CLEANING

- A. See Section 01 7000 - Execution and Closeout Requirements for additional requirements.
- B. Clean faced panels in accordance with manufacturer's maintenance instructions, using cleaning materials and methods acceptable to manufacturer.

3.05 PROTECTION

- A. Protect installed products until Date of Substantial Completion.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 07 4646

SECTION 07 5400
THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Adhered system with thermoplastic roofing membrane.
- B. Insulation, flat and tapered.
- C. Vapor retarder.
- D. Deck sheathing.
- E. Flashings.
- F. Roofing cant strips, stack boots, roofing expansion joints, and walkway pads.

1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Wood cant strips.
- B. Section 07 7100 - Roof Specialties: Prefabricated roofing expansion joint flashing.
- C. Section 07 7200 - Roof Specialties: Fall protection.

1.03 REFERENCE STANDARDS

- A. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.
- B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2021.
- C. ASTM D6878/D6878M - Standard Specification for Thermoplastic Polyolefin-Based Sheet Roofing; 2021.
- D. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- E. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces; 2011 (Reapproved 2019).
- F. FM (AG) - FM Approval Guide; current edition.
- G. FM DS 1-28 - Wind Design; 2015, with Editorial Revision (2022).
- H. NRCA (RM) - The NRCA Roofing Manual; 2024.
- I. NRCA (WM) - The NRCA Waterproofing Manual; 2021.
- J. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.
 - 1. Review preparation and installation procedures and coordinating and scheduling required with related work.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners.
- C. Shop Drawings: Submit drawings that indicate joint or termination detail conditions, conditions of interface with other materials, and paver layout.
- D. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.
- E. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.

H. Warranty Documentation:

1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
2. Submit installer's written verification that installation complies with warranty conditions for waterproof membrane.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of this section with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 7419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact, unless otherwise indicated.
- C. Store materials in weather protected environment, clear of ground and moisture.
- D. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.
- E. Protect foam insulation from direct exposure to sunlight.

1.08 FIELD CONDITIONS

- A. Do not apply roofing membrane during unsuitable weather.
- B. Do not apply roofing membrane when ambient temperature is below 40 degrees F or above (per mfr.) degrees F.
- C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
- E. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.09 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Material Warranty: Provide membrane manufacturer's warranty agreeing to replace material that shows manufacturing defects within five years after installation.
- C. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
 1. Warranty Term: 20 years.
 2. For repair and replacement include costs of both material and labor in warranty.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Thermoplastic Polyolefin (TPO) Membrane Roofing Materials:
 1. Carlisle Roofing Systems, Inc.; SureWeld
 2. Firestone Building Products; UltraPly TPO XR 115.
 3. Flex Membrane International Corporation; Flex TPO Plus.
 4. GAF EverGuard TPO.
 5. GenFlex Roofing Systems, LLC.
 6. Versico; VersiWeld TPO.
 7. Mule-Hide Products Co, Inc.; Standard TPO.

8. John Mansville; TPO.
9. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ROOFING

- A. Thermoplastic Membrane Roofing: One ply membrane, mechanically fastened, over vapor retarder and insulation.
- B. Roofing Assembly Requirements:
 1. Solar Reflectance Index (SRI): 78, minimum, calculated in accordance with ASTM E1980.
 - a. Field applied coating may not be used to achieve specified SRI.
 2. Roof Covering External Fire Resistance Classification: UL (FRD) Class A.
 3. Factory Mutual Classification: Class 1 and windstorm resistance of 1-90, in accordance with FM DS 1-28.
 4. Insulation Thermal Resistance (R-Value): 5.5 per inch, minimum.
- C. Acceptable Insulation Types - Tapered Application:
 1. Tapered polyisocyanurate board.

2.03 MEMBRANE ROOFING AND ASSOCIATED MATERIALS

- A. Membrane Roofing Materials:
 1. TPO: Thermoplastic polyolefin (TPO) complying with ASTM D6878/D6878M, sheet contains reinforcing fabrics or scrims.
 - a. Thickness: 80 mil, 0.080 inch, minimum.
 2. Sheet Width:
 3. Solar Reflectance: 0.75, minimum, initial, and 0.65, minimum, 3-year, certified by Cool Roof Rating Council.
 4. Thermal Emissivity: 0.80, minimum, initial, and 0.79, minimum, 3-year, certified by Cool Roof Rating Council.
 5. Color: White.
- B. Seaming Materials: As recommended by membrane manufacturer.
- C. Membrane Fasteners: As recommended and approved by membrane manufacturer.
- D. Vapor Retarder: Material approved by roof manufacturer complying with requirements of fire rating classification; compatible with roofing and insulation materials. Prime substrate per manufacturer.
 1. Fire-retardant adhesive.
 2. Vapor Permeability: 1.0 perm inch, measured in accordance with ASTM E96/E96M.
- E. Flexible Flashing Material: Same material as membrane.
- F. Separation Sheet: Sheet polyethylene; 2 mil, 0.002 inch thick.
 1. Provide if required by manufacturer.

2.04 DECK SHEATHING AND COVER BOARDS

- A. Deck Sheathing and Cover Board: Glass-mat faced gypsum panels complying with ASTM C1177/C1177M.
 1. Thickness: 1/4 inch, fire-resistant.
 2. Products:
 - a. Georgia-Pacific; DensDeck.
 - b. USG Corporation; Securerock.
 - c. National Gypsum Company; DEXcell.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

2.05 INSULATION

- A. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, complying with ASTM C1289.
 1. Classifications:

- a. Type II: Faced with either cellulosic facers or glass fiber mat facers on both major surfaces of the core foam.
 - 1) Class 1 - Faced with glass fiber reinforced cellulosic facers on both major surfaces of the core foam.
 - 2) Compressive Strength: Classes 1-2-3, Grade 1, 16 psi (110 kPa), minimum.
 - 3) Thermal Resistance, R-value: At 1-1/2 inches thick; Class 1, Grades 1-2-3, 8.4 (1.48), minimum, at 75 degrees F.
- 2. Tapered Board: Slope as indicated; minimum thickness 1/2 inch; fabricate of fewest layers possible.
- 3. Layers: 2 Minimum.

2.06 ACCESSORIES

- A. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.
- B. Cant and Edge Strips: Wood fiberboard, compatible with roofing materials; cants formed to 45 degree angle.
- C. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches wide; self adhering.
- D. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
- E. Membrane Adhesive: As recommended by membrane manufacturer.
- F. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.
- G. Thinners and Cleaners: As recommended by adhesive manufacturer, compatible with membrane.
- H. Insulation Adhesive: As recommended by insulation manufacturer.
- I. Roofing Nails: Galvanized, hot-dipped type, size and configuration as required to suit application.
- J. Strip Reglet Devices: Galvanized steel, maximum possible lengths per location, with attachment flanges.
- K. Sealants: As recommended by membrane manufacturer.
- L. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.
 - 1. Composition: Roofing membrane manufacturer's standard.
 - 2. Surface Color: White or Yellow.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
- D. Verify deck surfaces are dry and free of snow or ice.
- E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.02 PREPARATION - WOOD DECK

- A. Verify flatness and tightness of joints in wood decking; fill knot holes with latex filler.
- B. Confirm dry deck by moisture meter with 12 percent moisture maximum.

3.03 INSTALLATION, GENERAL

- A. Perform work in accordance with manufacturer's instructions, NRCA (RM), and NRCA (WM) applicable requirements.
- B. Do not apply roofing membrane during cold or wet weather conditions.

- C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.
- D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
- F. Coordinate this work with installation of associated counterflashings installed by other sections as the work of this section proceeds.

3.04 INSTALLATION - VAPOR RETARDER AND INSULATION, UNDER MEMBRANE

- A. Install vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
 - 1. Extend vapor retarder under cant strips and blocking to deck edge.
 - 2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.
- B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.
- C. Attachment of Insulation:
 - 1. Mechanically fasten insulation to deck in accordance with roofing manufacturer's instructions and FM DS 1-28 Factory Mutual requirements.
- D. Cover Boards: Mechanically fasten cover boards in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.
- E. Lay subsequent layers of insulation with joints staggered minimum 6 inches from joints of preceding layer.
- F. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- G. Tape joints of insulation in accordance with roofing and insulation manufacturers' instructions.
- H. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 18 inches.
- I. Do not install more insulation than can be covered with membrane in same day.

3.05 INSTALLATION - MEMBRANE

- A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
- B. Shingle joints on sloped substrate in direction of drainage.
- C. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
- D. Mechanical Attachment: Install membrane and mechanical attachment devices in accordance with manufacturer's instructions.
- E. At intersections with vertical surfaces:
 - 1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
 - 2. Fully adhere flexible flashing over membrane and up to nailing strips.
 - 3. Secure flashing to nailing strips at 4 inches on center.
 - 4. Insert flashing into reglets and secure.
- F. Around roof penetrations, seal flanges and flashings with flexible flashing.
- G. Install roofing expansion joints where indicated. Make joints watertight.
 - 1. Install prefabricated joint components in accordance with manufacturer's instructions.
- H. Coordinate installation of roof drains and sumps and related flashings.

3.06 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Owner will provide testing services, and Contractor to provide temporary construction and materials for testing in accordance with requirements.

3.07 CLEANING

- A. See Section 01 7000 - Execution and Closeout Requirements for additional requirements.
- B. Remove bituminous markings from finished surfaces.
- C. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.
- D. Repair or replace defaced or damaged finishes caused by work of this section.

3.08 PROTECTION

- A. Protect installed roofing and flashings from construction operations.
- B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION 07 5400

SECTION 07 6200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Fabricated sheet metal items, including flashings, counterflashings, gutters, downspouts, sheet metal roofing, and other items indicated or required, and other items indicated in Schedule.
- B. Sealants for joints within sheet metal fabrications.
- C. Precast concrete splash pads.

1.02 RELATED REQUIREMENTS

- A. Section 07 7123 - Manufactured Gutters and Downspouts.
- B. Section 08 1113 - Hollow Metal Doors and Frames: Head flashings and as indicated.
- C. Section 08 4313 - Aluminum-Framed Storefronts: Flashings as indicated.
- D. Section 08 5313 - Vinyl Windows: Perimeter Flashings related to other Sections.

1.03 REFERENCE STANDARDS

- A. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- F. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- G. ASTM D2178/D2178M - Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing; 2015a (Reapproved 2021).
- H. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2018).
- I. CDA A4050 - Copper in Architecture - Handbook; current edition.
- J. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- C. Samples: Submit one samples 12x12 inch in size illustrating metal finish color.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.
- B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 5 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 7419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- C. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS**2.01 SHEET MATERIALS**

- A. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal, shop pre-coated with PVDF coating.
 - 1.
 - 2. Polyvinylidene Fluoride (PVDF) Coating: Superior performing organic powder coating, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
 - 3. Color: As selected by Architect from manufacturer's standard colors, or to match adjacent sheet metal.
 - 4. Applications: in all locations unless otherwise specified, including downspoints and gutters.
- B. Pre-Finished Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 18 gauge, 0.040 inch thick; plain finish shop pre-coated with silicone modified polyester coating.
 - 1. Fluoropolymer Coating: High performance organic powder coating, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system.
 - 2. Color: As selected by Architect from manufacturer's standard colors.
 - 3. Application: At locations adjacent to incorporated with aluminum materials, such as Storefronts.
- C. Stainless Steel: ASTM A666, Type 304 alloy, soft temper, 28 gauge, 0.0156 inch thick; smooth No. 4 - Brushed finish.
 - 1. Where indicated, where flashing is within 6 inches of ground level, and storefront sill flashings.

2.02 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Fabricate cleats of same material as sheet, minimum 2 inches wide, interlocking with sheet.
- C. Form pieces in longest possible lengths.
- D. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- E. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- F. Fabricate corners from one piece with minimum 18-inch long legs; seam for rigidity, seal with sealant.
- G. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip, unless otherwise detailed.
- H. Fabricate flashings to allow toe to extend 2 inches over roofing paver. Return and brake edges.

2.03 GUTTERS AND DOWNSPOUTS

- A. Gutters: SMACNA (ASMM) Rectangular profile.
- B. Downspouts: Profile as indicated.
- C. Gutters and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA (ASMM).
- D. Accessories: Profiled to suit gutters and downspouts.
 - 1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
 - 2. Gutter Supports: Brackets.
 - 3. Downspout Supports: Brackets.

- E. Splash Pads: Precast concrete type, of size and profiles indicated; minimum 3,000 psi at 28 days, with minimum 5 percent air entrainment.
- F. Downspout Boots: Steel.
- G. Downspout Extenders: Same material and finish as downspouts.
- H. Seal metal joints.

2.04 EXTERIOR PENETRATION FLASHING PANELS

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

2.05 ACCESSORIES

- A. Fasteners: Same material and finish as flashing metal, with soft neoprene washers.
- B. Underlayment: ASTM D2178/D2178M, glass fiber roofing felt.
- C. Slip Sheet: Rosin-sized sheathing paper.
- D. Primer Type: Zinc chromate.
- E. Protective Backing Paint: Zinc molybdate alkyd.
- F. Concealed Sealants: Non-curing butyl sealant.
- G. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- H. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.
- I. Reglets: Surface-mounted type, galvanized steel; face and ends covered with plastic tape.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.
- C. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch.

3.03 INSTALLATION

- A. Insert flashings into reglets to form tight fit; secure in place with lead wedges; pack remaining spaces with lead wool; seal flashings into reglets with sealant.
- B. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
- C. Apply plastic cement compound between metal flashings and felt flashings.
- D. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- E. Exterior Flashing Receivers: Install in accordance with manufacturer's recommendations, and in proper relationship with adjacent construction, and as follows:
 - 1. Secure receiver at perimeter of wall opening with adhesives or fasteners.
 - 2. Place flashing into receiver channel.
 - 3. Secure flashing with receiver clip.
- F. Seal metal joints watertight.
- G. Secure gutters and downspouts in place with concealed fasteners.
- H. Slope gutters 1/4 inch per 10 feet, minimum.
- I. Connect downspouts to downspout boots, and grout connection watertight.

J. Set splash pads under downspouts.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for field inspection requirements.

B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

3.05 SCHEDULE

END OF SECTION 07 6200

SECTION 07 7600
ROOF PAVERS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Roof pavers.
- B. Pedestals.

1.02 RELATED REQUIREMENTS

- A. Section 07 5400 - Thermoplastic Membrane Roofing: Substrate for roof paver system.

1.03 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2023.
- C. ASTM E303 - Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester; 2022.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.
 - 1. Review preparation and installation procedures and coordinating and scheduling required with related work.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating paver and pedestal materials.
- C. Shop Drawings: Submit shop drawings that indicate paver and pedestal layout, including overall plan and detail drawings of system components.
- D. Samples of Pavers: Submit two samples for each type, color and texture indicated.
- E. Manufacturer's Installation Instructions: Indicate substrate precautions, special procedures, and perimeter conditions requiring special attention.
- F. Installer's qualification statement.
- G. Warranty Documentation:
 - 1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
 - 2. Submit documentation from installer that installation complies with warranty conditions for roof paver system.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 7419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- C. Store materials at least 4 inches above ground in dry location, and covered with polyethylene sheet to protect from contact with materials that may cause staining or discoloration.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

- B. Manufacturer Warranty: Provide 2-year manufacturer warranty to replace material that shows manufacturing defects. Complete forms in Owner's name and register with manufacturer.
- C. Installer Warranty: Provide 2-year warranty for defects of labor and/or workmanship commencing on the Date of Substantial Completion. Complete forms in Owner's name and register with installer.

PART 2 PRODUCTS

2.01 ROOF PAVERS

- A. 2'x2' Ipe Wood Tile: texture and color as indicated; supported by adjustable pedestal system.
 - 1. Comply with local wind load resistance requirements of ASCE 7.
 - 2. Texture and Color: As selected by Architect from manufacturer's standard line.
 - 3. Length and Width: 23-7/8 by 23-7/8 inches, nominal.
 - 4. Thickness: 2 inches, nominal.
 - 5. Surface Finish, Non-Slip; Slip Resistance: Provide walking surfaces of exterior pavers with Pendulum Test Value (PTV) of at least 40 in accordance with ASTM E303 test method.
 - 6. Products:
 - a. Bison Innovative Products, Basis of design.
 - b. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PEDESTALS

- A. Pedestals: High impact plastic; adjustable height.
 - 1. Provide Product acceptable to tile system manufacturer.
 - 2. Comply with local wind load resistance requirements of ASCE 7.
 - 3. Self-Ignition Temperature: Provide plastic pedestal components with self-ignition temperature greater than 650 degrees F in accordance with ASTM D1929 test method.
 - 4. Base Diameter: 8 inches, minimum.
 - 5. Pedestal Height: Within 3/4" inch to 24 inches, with use of 4-3/16 inch diameter SDR-35 PVC pipe, with maximum static load of 2,000 lb per pedestal in system.
 - 6. Products:
 - a. Bison ScrewJack Pedestal: Bison Innovative Products
 - b. Westile, an Oldcastle Company; Screwjack Pedestal System.
 - c. Black Jack by Abbotsford Concrete Products.
 - d. Terra-System One, Wausau Tile, Inc.
 - e. Paver Pedestal System, by Tile Tech Pavers.
 - f. AWS Pedestal System, distributed by Puget Lite-Pavers.
 - g. Substitutions: See Section 01 6000 - Product Requirements.

2.03 ACCESSORIES

- A. Paver Edge Restraints: Provide closure to underside of pavers along perimeter edge of pavers or areas that change elevation or step-down; provide restraint system that fully contain pavers and tie back into building wall or parapet.
 - 1. Metal Flashing: Two piece metal edge, at least 22 gauge, 0.03 inch prefinished galvanized metal supported from paver edge and ledger board anchored to pedestals.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive this work.
- B. Verify substrate is supported and secure.
- C. Verify substrate is clean and smooth, dry and free of snow or ice, flat without depressions, waves or projections, properly sloped and suitable for installation of roof paver system.
- D. Verify that roof openings, curbs, and penetrations through roof are solidly set.

- E. Verify system elevations, required pedestal heights, and substrate dimensions.

3.02 PREPARATION

- A. Use of pedestal system is for pedestrian traffic only and each side of deck system must be restrained containing decking panels with perimeter blocking or walls; movement of decking panels laterally is not permitted.
- B. Membrane waterproofing and protection board surfaces used to support pedestals to be broom clean, free of frost, dirt, oil or any rough foreign matter that may impair substrate material manufacturer's warranty requirements.
- C. Provide substrate for pedestals with slope and positive drainage in accordance with applicable building codes.
- D. Substrate surface that will support paver and pedestal system must be structurally capable of carrying dead and live loads anticipated.
 - 1. Insulation Under Roofing Membrane: Insulation installed within a roofing system below roof paver supports must meet roofing membrane manufacturer's recommended installation instructions and have compressive strength of at least 60 psi.
 - 2. Drainage Mat: Install drainage mat in accordance with manufacturer's recommendations to avoid crushing.
- E. If preparation is responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.
- F. Commencement of this work implies acceptance of surfaces and substrate conditions.

3.03 INSTALLATION

- A. Perform work in accordance with manufacturer's written installation instructions and applicable requirements in coordination with project attributes, paver type being installed, pattern, grid layout, starting point, and finished elevation as indicated on approved shop drawings.
- B. Install pavers on pedestals in accordance with manufacturer's instructions.
 - 1. Fully support edges; shim and adjust pavers to provide level surface.
 - 2. Provide approximately 1/8 inch space between pavers to permit surface water drainage.
- C. Paver Edge Restraints: Install exposed paver edge restraints in accordance with roof paver manufacturer's instructions.
- D. Edge Treatment: Install dividers and edging where indicated.
 - 1. Provide intermittent spacing between dividers to allow water to flow between areas.
 - 2. Extend protection layers up vertical surfaces of dividers and edging to retain overburden.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Inspect during installation to ensure that grid spacer lines are being maintained in a straight and consistent pattern and that deck roof pavers are level and not rocking.
- C. Unless otherwise specified in writing to allow for expansion, inspect to ensure that spacing between pavers at perimeter walls does not exceed a tab width.
- D. Inspect during installation to ensure that pedestrian entry or access points to roof paver areas are level and that pavers are not randomly raised or uneven creating a tripping or safety hazard.
- E. Verify that deck pedestal heights in excess of 16 inches have been braced in accordance with manufacturers written installation instructions.

3.05 CLEANING

- A. Remove markings from finished surfaces, or replace defaced components of roof pavers system if markings cannot be removed.
- B. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.

C. Repair or replace defaced or damaged finishes caused by work of this section.

3.06 PROTECTION

A. Protect installed roof pavers from construction operations.

B. Where traffic must continue over finished roof pavers, protect surfaces using durable materials.

END OF SECTION 07 7600

SECTION 07 9200
JOINT SEALANTS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Nonsag gunnable joint sealants.
- B. Self-leveling pourable joint sealants.
- C. Joint backings and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions: Additional requirements for sealants and primers.
- B. Section 09 2116 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.

1.03 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015 (Reapproved 2022).
- B. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants; 2018.
- C. ASTM C834 - Standard Specification for Latex Sealants; 2017.
- D. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2022.
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- F. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2016.
- G. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.
- H. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2018.
- I. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2014.
- J. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2018.
- K. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints; 2019 (Reapproved 2020).
- L. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
- M. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- N. SWRI (VAL) - SWR Institute Validated Products Directory; Current Edition.
- O. UL 263 - Standard for Fire Tests of Building Construction and Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 4. Substrates the product should not be used on.
 - 5. Substrates for which use of primer is required.
 - 6. Substrates for which laboratory adhesion and/or compatibility testing is required.

7. Installation instructions, including precautions, limitations, and recommended backing materials and tools.
 8. Sample product warranty.
 9. Certification by manufacturer indicating that product complies with specification requirements.
 10. SWRI Validation: Provide currently available sealant product validations as listed by SWRI (VAL) for specified sealants.
- C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
 - D. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
 - E. Samples for Verification: Where custom sealant color is specified, obtain directions from Architect and submit at least two physical samples for verification of color of each required sealant.
 - F. Sustainable Design Documentation: For sealants and primers, submit VOC content and emissions documentation; see Section 01 6116.
 - G. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.
 - H. Installation Plan: Submit at least four weeks prior to start of installation.
 - I. Preinstallation Field Adhesion Test Plan: Submit at least two weeks prior to start of installation.
 - J. Field Quality Control Plan: Submit at least two weeks prior to start of installation.
 - K. Preinstallation Field Adhesion Test Reports: Submit filled out Preinstallation Field Adhesion Test Reports log within 10 days after completion of tests; include bagged test samples and photographic records.
 - L. Installation Log: Submit filled-out log for each length or instance of sealant installed.
 - M. Field Quality Control Log: Submit filled-out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.
 - N. Executed warranty.

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 three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience.
- D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- E. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
 1. Adhesion Testing: In accordance with ASTM C794.
 2. Compatibility Testing: In accordance with ASTM C1087.
 3. Stain Testing: In accordance with ASTM C1248; required only for masonry substrates.
 4. Allow sufficient time for testing to avoid delaying the work.
 5. Deliver sufficient samples to manufacturer for testing.
 6. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.
- F. Installation Plan: Include schedule of sealed joints, including the following:
 1. Joint width indicated in Contract Documents.

2. Joint depth indicated in Contract Documents; to face of backing material at centerline of joint.
 3. Method to be used to protect adjacent surfaces from sealant droppings and smears, with acknowledgment that some surfaces cannot be cleaned to like-new condition and therefore prevention is imperative.
 4. Approximate date of installation, for evaluation of thermal movement influence.
 5. Installation Log Form: Include the following data fields, with known information filled out.
 - a. Unique identification of each length or instance of sealant installed.
 - b. Location on project.
 - c. Substrates.
 - d. Sealant used.
 - e. Stated movement capability of sealant.
 - f. Primer to be used, or indicate no primer is used.
 - g. Size and actual backing material used.
 - h. Date of installation.
 - i. Name of installer.
 - j. Actual joint width; provide space to indicate maximum and minimum width.
 - k. Actual joint depth to face of backing material at centerline of joint.
 - l. Air temperature.
- G. Preinstallation Field Adhesion Test Plan: Include destructive field adhesion testing of one sample of each combination of sealant type and substrate, except interior acrylic latex sealants, and include the following for each tested sample.
1. Identification of testing agency.
 2. Name(s) of sealant manufacturer's field representatives who will be observing.
 3. Preinstallation Field Adhesion Test Log Form: Include the following data fields, with known information filled out.
 - a. Substrate; if more than one type of substrate is involved in a single joint, provide two entries on form, for testing each sealant substrate side separately.
 - b. Test date.
 - c. Location on project.
 - d. Sealant used.
 - e. Stated movement capability of sealant.
 - f. Test method used.
 - g. Date of installation of field sample to be tested.
 - h. Date of test.
 - i. Copy of test method documents.
 - j. Age of sealant upon date of testing.
 - k. Test results, modeled after the sample form in the test method document.
 - l. Indicate use of photographic record of test.
- H. Field Quality Control Plan:
1. Visual inspection of entire length of sealant joints.
 2. Nondestructive field adhesion testing of sealant joints, except interior acrylic latex sealants.
 - a. Test the entire length of every sealant joint.
 3. Destructive field adhesion testing of sealant joints, except interior acrylic latex sealant.
 - a. For each different sealant and substrate combination, allow for one test every 100 feet in the first 1,000 linear feet, and one test per 1,000 linear feet thereafter, or once per floor on each elevation.
 - b. If any failures occur in the first 1,000 linear feet, continue testing at frequency of one test per 500 linear feet at no extra cost to Owner.
 4. Field testing agency's qualifications.

5. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.
- I. Field Adhesion Test Procedures:
 1. Allow sealants to fully cure as recommended by manufacturer before testing.
 2. Have a copy of the test method document available during tests.
 3. Take photographs or make video records of each test, with joint identification provided in the photos/videos; for example, provide small erasable whiteboard positioned next to joint.
 4. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
 5. When performing destructive tests, also inspect the opened joint for proper installation characteristics recommended by manufacturer, and report any deficiencies.
 6. Deliver the samples removed during destructive tests in separate sealed plastic bags, identified with project, location, test date, and test results, to Owner.
 7. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.
- J. Nondestructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Nondestructive Spot Method.
 1. Record results on Field Quality Control Log.
 2. Repair failed portions of joints.
- K. Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Destructive Tail Procedure.
 1. Sample: At least 18 inches long.
 2. Minimum Elongation Without Adhesive Failure: Consider the tail at rest, not under any elongation stress; multiply the stated movement capability of the sealant in percent by two; then multiply 1 inch by that percentage; if adhesion failure occurs before the 1-inch mark is that distance from the substrate, the test has failed.
 3. If either adhesive or cohesive failure occurs before minimum elongation, take necessary measures to correct conditions and retest; record each modification to products or installation procedures.
 4. Record results on Field Quality Control Log.
 5. Repair failed portions of joints.
- L. Field Adhesion Tests of Joints: Test for adhesion using most appropriate method in accordance with ASTM C1521, or another applicable method as recommended by manufacturer.

1.06 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.
- C. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nonsag Sealants:
 1. Adfast USA Inc.
 2. Adhesives Technology Corporation.
 3. BASF Construction Chemicals-Building Systems.

4. Bostik Inc.
 5. Dow Corning Corporation.
 6. Everkem Diversified Products, Inc.
 7. Franklin International, Inc.
 8. Henry Company.
 9. Hilti, Inc.
 10. Momentive Performance Materials, Inc. (formerly GE Silicones).
 11. Pecora Corporation.
 12. Sherwin-Williams Company.
 13. Sika Corporation.
 14. Specified Technologies Inc.
 15. Tremco Commercial Sealants & Waterproofing..
 16. W.R. Meadows, Inc.
 17. Substitutions: See Section 01 6000 - Product Requirements.
- B. Self-Leveling Sealants:
1. Adhesives Technology Corporation.
 2. BASF Construction Chemicals-Building Systems.
 3. Bostik Inc.
 4. Dow Corning Corporation.
 5. Master Builders Solutions.
 6. Pecora Corporation.
 7. Sherwin-Williams Company.
 8. Sika Corporation.
 9. Tremco Commercial Sealants & Waterproofing.
 10. W.R. Meadows, Inc.
 11. Substitutions: See Section 01 6000 - Product Requirements.

2.02 JOINT SEALANT APPLICATIONS

- A. Scope:
1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to:
 - a. Wall expansion and control joints.
 - b. Joints between door, window, and other frames and adjacent construction.
 - c. Joints between different exposed materials.
 - d. Openings below ledge angles in masonry.
 - e. Other joints indicated below.
 2. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
 - 1) Exception: Such gaps and openings in gypsum board and plaster finished stud walls and suspended ceilings. See Section 09 2116 for additional information.
 - 2) Exception: Through-penetrations in sound-rated assemblies that are also fire-rated.
 - c. Other joints indicated below.
 3. Do not seal the following types of joints:
 - a. Intentional weep holes in masonry.

- b. Joints indicated to be treated with manufactured expansion joint cover, or some other type of sealing device.
 - c. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
 - d. Joints where installation of sealant is specified in another section.
 - e. Joints between suspended panel ceilings/grid and walls.
- B. Type A - Exterior Joints: Use non-sag non-staining silicone sealant, unless otherwise indicated.
- 1. Type V - Lap Joints in Sheet Metal Fabrications: Butyl rubber, non-curing.
 - 2. Type V - Lap Joints between Manufactured Metal Panels: Butyl rubber, non-curing.
 - 3. Type 02 - Control and Expansion Joints in Concrete Paving: Self-leveling polyurethane "traffic-grade" sealant.
 - 4. Type 02 - Wiring Slots in Concrete Paving: Self-leveling polyurethane sealant.
- C. Type I - Interior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.
- 1. Type R - Wall and Ceiling Joints in Non-Wet Areas: Acrylic emulsion latex sealant.
 - 2. Type J - Wall and Ceiling Joints in Wet Areas, including at all bathroom tile bases: Non-sag polyurethane sealant for continuous liquid immersion.
 - 3. Type J - Floor Joints in Wet Areas: Non-sag polyurethane "non-traffic-grade" sealant suitable for continuous liquid immersion.
 - 4. Type G - Wall, Ceiling, and Floor Joints Where Tamper-Resistance is Required: Non-sag tamper-resistant silyl-terminated polyurethane sealant.
 - 5. Type D - Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.
 - 6. Type R - In Sound-Rated Assemblies: Acrylic emulsion latex sealant.
 - 7. Type 12 - Narrow Control Joints in Interior Concrete Slabs: Semi-rigid, Self-leveling polyurea sealant. Traffic grade.
 - 8. Type 13 - Other Floor Joints: Self-leveling polyurethane "traffic-grade" sealant.
 - 9. Type 09: Joints and voids at exterior framing, windows, and doors. Polyurethane foam.
- D. Interior Wet Areas: Bathrooms, restrooms, kitchens, food service areas, and food processing areas; fixtures in wet areas include plumbing fixtures, food service equipment, countertops, cabinets, and other similar items.
- E. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.
- F. Areas Where Tamper-Resistance is Required: As indicated on drawings.

2.03 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products with acceptable levels of volatile organic compound (VOC) content; see Section 01 6116.
- B. Colors: As indicated on drawings.

2.04 NONSAG JOINT SEALANTS

- A. Type A - Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus 100 percent and minus 50 percent, minimum.
 - 2. Nonstaining to Porous Stone: Nonstaining to light-colored natural stone when tested in accordance with ASTM C1248.
 - 3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
 - 4. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
 - 5. Color: Match adjacent finished surfaces.
 - 6. Cure Type: Single-component, neutral moisture curing.
 - 7. Service Temperature Range: Minus 20 to 180 degrees F.

- B. Type D - Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
 - 1. Color: White.
- C. Type G - Tamper-Resistant, Silyl-Terminated Polyurethane (STPU) Sealant: ASTM C920, Grade NS, Uses M and A; single component; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus ___ percent, minimum
 - 2. Hardness Range: 25 to 30, Shore A, when tested in accordance with ASTM C661.
 - 3. Color: To be selected by Architect from manufacturer's standard range.
 - 4. Service Temperature Range: Minus 40 to 180 degrees F.
- D. Type I - Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
 - 2. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 - 3. Color: To be selected by Architect from manufacturer's standard range.
 - 4. Service Temperature Range: Minus 40 to 180 degrees F.
- E. Type R - Acrylic Emulsion Latex: Water-based; ASTM C834, single component, non-staining, non-bleeding, non-sagging; not intended for exterior use.
 - 1. Color: To be selected by Architect from manufacturer's standard range.
 - 2. Grade: ASTM C834; Grade 0 Degrees F (Minus 18 Degrees C).
- F. Type T - Acrylic Latex Sealant: ASTM C834; for use as acoustical sealant and in firestopping systems for expansion joints and through penetrations.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Fire Rated System: Complies with UL 263 and ASTM E119 with UL fire resistance classifications.
 - 3. Products:
 - a. USG Acoustical Sealant.
 - b. Tremco Acoustical Sealant.
 - c. 3M Fire Barrier 1000 N/S, fire rated.
 - d. Dow Corning 790, smoke rated.
- G. Type V - Non-Curing Butyl Sealant: Solvent-based, single component, non-sag, non-skinning, non-hardening, non-bleeding; non-vapor-permeable; intended for fully concealed applications.

2.05 SELF-LEVELING JOINT SEALANTS

- A. Type 02 - Self-Leveling Polyurethane Sealant: ASTM C920, Grade P, Uses M and A; single or multi-component; explicitly approved by manufacturer for traffic exposure; not expected to withstand continuous water immersion .
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
 - 2. Hardness Range: 35 to 55, Shore A, when tested in accordance with ASTM C661.
 - 3. Color: To be selected by Architect from manufacturer's standard range.
 - 4. Service Temperature Range: Minus 40 to 180 degrees F.
- B. Type 04 - Self-Leveling Polyurethane Sealant for Continuous Water Immersion: Polyurethane; ASTM C920, Grade P, Uses M and A; single or multi-component; explicitly approved by manufacturer for traffic exposure and continuous water immersion.
- C. Type 09 - Flexible Polyurethane Foam: Single component, gun grade, and low-expanding.
 - 1. Applications: Joint filler for around windows and door, and other voids in the exterior envelope to provide thermal and sound barrier.
- D. Type 12 - Semi-Rigid Self-Leveling Polyurea Joint Filler: Two-component, 100 percent solids; intended for filling cracks and control joints not subject to significant movement; rigid enough to support concrete edges under traffic.

1. Applications: Joint filler for concrete slab saw-cuts and narrow cracks.
2. Durometer Hardness, Type A: 75, minimum, after seven days when tested in accordance with ASTM D2240.
3. Color: To be selected by Architect from manufacturer's standard colors.
4. Joint Width, Minimum: 1/8 inch.
5. Joint Width, Maximum: 1/2 inch.
6. Joint Depth: Provide product suitable for joints from 1/8 inch to 1 inch in depth excluding space for backer rod.

2.06 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
 1. Type for Joints Not Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type O - Open Cell Polyurethane.
 2. Type for Joints Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type B - Bi-Cellular Polyethylene.
 3. Open Cell: 40 to 50 percent larger in diameter than joint width.
 4. Closed Cell and Bi-Cellular: 25 to 33 percent larger in diameter than joint width.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- E. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.
- D. Preinstallation Adhesion Testing: Install a sample for each test location indicated in the test plan.
 1. Test each sample as specified in PART 1 under QUALITY ASSURANCE article.
 2. Notify Architect of date and time that tests will be performed, at least seven days in advance.
 3. Arrange for sealant manufacturer's technical representative to be present during tests.
 4. Record each test on Preinstallation Adhesion Test Log as indicated.
 5. If any sample fails, review products and installation procedures, consult manufacturer, or take other measures that are necessary to ensure adhesion; retest in a different location; if unable to obtain satisfactory adhesion, report to Architect.
 6. After completion of tests, remove remaining sample material and prepare joints for new sealant installation.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

- E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in an inconspicuous area to verify that it does not stain or discolor slab.

3.03 INSTALLATION

- A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Provide joint sealant installations complying with ASTM C1193.
- C. Install acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated:
 - 1. Width/depth ratio of 2:1.
 - 2. Neck dimension no greater than 1/3 of the joint width.
 - 3. Surface bond area on each side not less than 75 percent of joint width.
- E. Install bond breaker backing tape where backer rod cannot be used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- G. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- H. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.
- I. Concrete Floor Joint Filler: After full cure, shave joint filler flush with top of concrete slab.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.
- C. Non-Destructive Adhesion Testing: If there are any failures in first 100 linear feet, notify Architect immediately.
- D. Destructive Adhesion Testing: If there are any failures in first 1,000 linear feet, notify Architect immediately.
- E. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.
- F. Repair destructive test location damage immediately after evaluation and recording of results.

3.05 POST-OCCUPANCY

- A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width, i.e., at low temperature in thermal cycle. Report failures immediately and repair them.

END OF SECTION 07 9200

SECTION 08 1113
HOLLOW METAL DOOR AND WINDOW FRAMES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Non-fire-rated hollow metal door and window frames.
- B. Fire-rated hollow metal doors and frames.
- C. Accessories, including glazing, louvers, and matching panels.

1.02 RELATED REQUIREMENTS

- A. Section 08 7100 - Door Hardware.
- B. Section 08 8000 - Glazing: Glass for borrowed lites.
- C. Section 09 9123 - Interior Painting: Field painting.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2009.
- C. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2018.
- D. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2020.
- E. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2017.
- F. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2020.
- G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- H. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2021a.
- I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2018a.
- J. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames; 2016.
- K. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- L. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.
- M. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2011.

1.04 SUBMITTALS

- A. See Section 01 3323 - Shop Drawings, Product Data, Samples
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- D. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.
- E. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.
- B. Quality Standard: In addition to requirements specified, provide hollow metal doors and frames from SDI Certified manufacturer products that comply with ANSI/DI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames."
www.steeldoor.org/sdicertified.php/#sle.
- C. Maintain at project site copies of reference standards relating to installation of products specified.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
 - 1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 2. Fleming Door Products, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 3. Stiles, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 4. Republic Doors, an Allegion brand: www.republicdoor.com/#sle.
 - 5. De La Fontaine Inc.
 - 6. Steelcraft, an Ingersoll Rand brand.
 - 7. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Door Frames:
 - 1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
 - 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 3. Provide backing for full set of hardware, including closers, for all doors regardless of whether all hardware is specified for that door. Provide solid backing at top of all exterior doors for installation or recessed magnet. Provide the same for interior doors with magnets.
 - 4. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturers standard.
 - 5. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
 - 6. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvanized) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.
 - a. Based on SDI Standards: Provide at least A40/ZF120 (galvanized) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvanized) for corrosive locations.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.
 - a. Physical Performance Level A 1 000 000 cycles; in accordance with ANSI/SDI A250.4.

2.03 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Provide reinforcing plates at all frames for closers whether or not they are specified for door.
- C. Interior Door and Window Frames, Non-Fire Rated: Full profile/continuously welded type. Double rabbet, unless otherwise noted.
 - 1. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
 - 2. Frame Finish: Factory primed and field finished.
- D. Door Frames, Fire-Rated: Full profile/continuously welded type. Double rabbet.
 - 1. Fire Rating: Same as door, labeled.
 - 2. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
 - 3. Frame Finish: Factory primed and field finished.
- E. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- F. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.
- G. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

2.04 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.
- B. Field Paint: Paint per Section 09 9123 - Interior Painting.

2.05 ACCESSORIES

- A. Glazing: As specified in Section 08 8000, factory installed.
- B. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.
- C. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.
- D. Insulation for Frames: Mineral wool or fiberglass batts cut to fill perimeter frame cavity.
- E. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- F. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Coordinate frame anchor placement with wall construction.
- C. Fill perimeter frame cavity with batt insulation.
- D. Install door hardware as specified in Section 08 7100.
- E. Coordinate installation of electrical connections to electrical hardware items.
- F. Touch up damaged factory finishes.

END OF SECTION 08 1113

SECTION 08 1416
FLUSH WOOD DOORS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Flush wood doors; flush configuration; fire-rated and non-rated.
- B. Wood doors with glazing.

1.02 RELATED REQUIREMENTS

- A. Section 08 1113 - Hollow Metal Door and Window Frames: Frames for wood doors.
- B. Section 08 4313 - Aluminum-Framed Storefronts: Interior door frames where indicated.
- C. Section 08 7100 - Door Hardware.

1.03 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. See Section 01 3323 - Shop Drawings, Product Data, Samples
- C. Product Data: Indicate door core materials and construction; veneer type and characteristics.
- D. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
 - 1. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
- E. Samples: Submit two samples of door veneer, 12 by 12 inch in size illustrating wood grain, stain color, and sheen.
- F. Test Reports: Show compliance with specified requirements for the following:
 - 1. Sound-retardant doors and frames; sealed panel tests are not acceptable.
- G. Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.06 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Interior Doors: Provide manufacturer's warranty for the life of the installation.
- C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Wood Veneer Faced Doors:
 - 1. Algoma Hardwoods.
 - 2. Eggers Industries.
 - 3. Graham Wood Doors.
 - 4. Vancouver Door, Inc.
 - 5. VT Industries.

6. Western Door Systems, Inc.
7. Oregon Door.
8. Marshfield Door Systems.
9. Substitutions: See Section 01 6000 - Product Requirements.

2.02 DOORS

- A. Doors: Refer to drawings for locations and additional requirements.
 1. Quality Standard: Premium Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
 2. Urea Formaldehyde: None Permitted.
 3. Laminating adhesives shall comply with Section 01 6116 - VOC Limitations.
 4. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
 1. Provide solid core doors at each location.
 2. Wood veneer facing with factory stain and transparent finish .

2.03 DOOR AND PANEL CORES

- A. Non-Rated Solid Core Doors: Type particleboard core (PC), plies and faces as indicated.

2.04 DOOR FACINGS

- A. Veneer Facing for Transparent Finish: Match existing door species and cut. _____, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with slip match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.
 1. Vertical Edges: Same species as face veneer.
- B. Facing Adhesive: Type I - waterproof.

2.05 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
 1. Provide solid blocks at lock edge for hardware reinforcement.
 2. Provide solid blocks at head of doors for closers.
 3. Provide solid blocking for other throughbolted hardware.
- C. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- D. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- E. Provide edge clearances in accordance with the quality standard specified.

2.06 FACTORY FINISHING - WOOD VENEER DOORS

- A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 1. Transparent:
 - a. System - 9 UV Curable Acrylated Epoxy Polyester or Urethane.
 - b. Stain: To match existing doors.
 - c. Sheen: Satin.
- B. Factory finish doors in accordance with approved sample.

2.07 ACCESSORIES

- A. Hollow Metal Door Frames: As specified in Section 08 1113.
- B. Door Hardware: As specified in Section 08 7100.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.

END OF SECTION 08 1416

SECTION 08 3100
ACCESS DOORS AND PANELS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Wall- and ceiling-mounted access units.

1.02 REFERENCE STANDARDS**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. See Section 01 3323 - Shop Drawings, Product Data, Samples
- C. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- D. Project Record Documents: Record actual locations of each access unit.

PART 2 PRODUCTS**2.01 ACCESS DOORS AND PANELS ASSEMBLIES**

- A. Wall-Mounted Units:
 - 1. Panel Material: Aluminum extrusions with gypsum board inlay.
 - 2. Size: As required, 18"x18" Minimum
 - 3. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
 - 4. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
- B. Wall-Mounted Units in Wet Areas:
 - 1. Panel Material: Steel, hot-dipped zinc, or zinc-aluminum-alloy coated.
 - 2. Size: As required, 18"x18" Minimum
 - 3. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
 - 4. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
- C. Fire-Rated Wall-Mounted Units:
 - 1. Wall Fire-Rating: As indicated on drawings.
- D. Ceiling-Mounted Units:
 - 1. Panel Material: Steel.
 - 2. Size - Lay-In Grid Ceilings: To match module of ceiling grid.
 - 3. Size - Other Ceilings: 18 by 18 inches Minimum.
 - 4. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
- E. Fire-Rated Ceiling-Mounted Units:
 - 1. Ceiling Fire-Rating: As indicated on drawings.

2.02 WALL- AND CEILING-MOUNTED ACCESS UNITS

- A. Wall- and Ceiling-Mounted Units: Factory-fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush; square and without rack or warp; coordinate requirements with type of installation assembly being used for each unit.
 - 1. Material: Steel.
 - 2. Style: Exposed frame with door surface flush with frame surface.
 - 3. Door Style: Single thickness with rolled or turned in edges.
 - 4. Frames: 16 gauge, 0.0598 inch, minimum thickness.
 - 5. Single Steel Sheet Door Panels: 1/16 inch, minimum thickness.

6. Double-Skinned Hollow Steel Sheet Door Panels: 16 gauge, 0.059 inch, minimum thickness, on both sides and along each edge.
7. Insulation: Non-combustible mineral wool or glass fiber.
8. Units in Fire-Rated Assemblies: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
9. Steel Finish: Primed.
10. Hardware:
 - a. Hardware for Fire-Rated Units: As required for listing.
 - b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings, and secure units rigidly in place.
- C. Position units to provide convenient access to concealed equipment when necessary.

END OF SECTION 08 3100

SECTION 08 4313
ALUMINUM-FRAMED STOREFRONTS AND DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed storefront, with vision glass.
- B. Weatherstripping.

1.02 RELATED REQUIREMENTS

- A. Section 08 7100 - Door Hardware: Hardware items other than specified in this section.
- B. Section 08 8000 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- A. AAMA - Aluminum Storefront and Entrance Manual.
- B. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.
- C. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- H. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- I. ASTM C1521 - Standard practice for evaluating adhesion of installed weatherproofing sealant joints.
- J. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.04 SUBMITTALS

- A. See Section 01 3323 - Shop Drawings, Product Data, Samples
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, internal drainage details .
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.06 WARRANTY

- A. Correct defective Work within a five year period after Date of Substantial Completion.
- B. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

- C. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 EXTERIOR STOREFRONT SYSTEM - BASIS OF DESIGN

- A. (SF) Center-Set Style, Thermally-Broken:
 - 1. Basis of Design: Kawneer; Trifab 451T.
 - 2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
- B. Substitutions: See Section 01 6000 - Product Requirements.
 - 1. For any product not identified as "Basis of Design", submit information as specified for substitutions.

2.02 SWINGING DOORS - BASIS OF DESIGN

- A. Wide Stile, Monolithic Glazing: Doors
 - 1. Applications: All interior doors in storefront system scheduled as aluminum doors.
 - 2. Basis of Design: 500 Heavy Wall, by Kawneer.
- B. Substitutions: See Section 01 6000 - Product Requirements.
 - 1. For any product not identified as "Basis of Design", submit information as specified for substitutions.

2.03 MANUFACTURERS

- A. Aluminum-Framed Storefront and Doors, Provide either the product identified as "Basis of Design" or an equivalent product of one of the manufacturers listed below, subject to meeting the requirements of this Section.
 - 1. EFCO Corporation.
 - 2. Oldcastle BuildingEnvelope.

2.04 ALUMINUM-FRAMED STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Finish: High performance organic coatings, 70 percent PVDF, factory finished.
 - 2. Finish Color (Frames, Fixed Units and Doors): As selected by Architect from manufacturer's standard line.
 - 3. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 4. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 - 5. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 - 6. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
 - 7. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
 - 8. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

9. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound.
10. Preparation for Window Treatments: Provide reinforced interior horizontal head rail.

2.05 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 1. Framing members for interior applications need not be thermally broken.
 2. Glazing Stops: Flush.
 3. Framing members shall be internally reinforced and secured at head and sill as necessary for structural performance requirements.
 4. Provide compensating head receptor where shown on drawings to accommodate deflection of floor deck above storefront.
 5. Provide snap-in flat filler at all jamb frames to allow backing for sealant to wall.
- B. Glazing: As specified in Section 08 8000.
- C. Swing Doors: Glazed aluminum.
 1. Finish: Same as storefront.

2.06 MATERIALS

- A. Structural Steel Sections: ASTM A36/A36M; galvanized in accordance with requirements of ASTM A123/A123M.
- B. Structural Supporting Anchors: See Section 05 1200.
- C. Structural Supporting Anchors Attached to Structural Steel: Design for bolted attachment.
- D. Structural Supporting Anchors Attached to Reinforced Concrete Members: Design for welded attachment to weld plates embedded in concrete.
- E. Fasteners: Stainless steel.
- F. Exposed Flashings: Aluminum sheet, 20 gage, 0.032 inch minimum thickness; finish to match framing members.
- G. Sealant for Setting Thresholds: Non-curing butyl type.
- H. Perimeter Sealant: Specified in Section 07 9005 - Joint Sealant.
- I. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- J. Glazing Accessories: As specified in Section 08 8000.
- K. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.

2.07 FINISHES

- A. Superior Performing Organic Coatings: AAMA 2605 multiple coat, thermally cured polyvinylidene fluoride (PVDF) system.
 1. Polyvinylidene fluoride (PVDF) multi-coat thermoplastic fluoropolymer coating system, including minimum 70 percent PVDF color topcoat and minimum total dry film thickness of 0.9 mil; color and gloss as selected from manufacturer's standard line typical. Custom color at window vents.

2.08 HARDWARE

- A. For each door, include weatherstripping and sill sweep strip.
- B. Other Door Hardware: As specified in Section 08 7100.
- C. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.
- D. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.

3.02 INSTALLATION

- A. In addition to requirements shown or specified comply with applicable provisions of AAMA "Storefront and Entrance Manual" for design, materials, fabrication, and installation of component parts.
- B. Install wall system in accordance with manufacturer's instructions.
- C. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- D. Provide alignment attachments and shims to permanently fasten system to building structure.
- E. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- F. Provide thermal isolation where components penetrate or disrupt building insulation.
- G. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- H. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- I. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 ADJUSTING

- A. Adjust operating hardware and sash for smooth operation.

3.04 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.

3.05 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 08 4313

SECTION 08 5313
VINYL WINDOWS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Vinyl-framed, factory-glazed windows.
- B. Operating hardware.
- C. Insect screens.
- D. Mockup.
- E. Field Testing.

1.02 RELATED REQUIREMENTS

- A. Section 07 9200 - Joint Sealants: Sealing joints between frames and adjacent construction.
- B. Section 08 8000 - Glazing.

1.03 REFERENCE STANDARDS

- A. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/Specification for Windows, Doors, and Skylights; 2017.
- B. AAMA 502 - Voluntary Specification for Field Testing of Newly Installed Fenestration Products; 2021.
- C. AAMA 701/702 - Performance Specification for Pile Weatherstrips (AAMA 701) and Polymer Weatherseals (AAMA 702); 2023.
- D. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.
- E. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).
- F. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors; 2002 (Reapproved 2018).
- G. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2015 (Reapproved 2023).
- H. ASTM E1332 - Standard Classification for Rating Outdoor-Indoor Sound Attenuation; 2016.
- I. ASTM E2112 - Standard Practice for Installation of Exterior Windows, Doors and Skylights; 2019c.
- J. ASTM F588 - Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact; 2017.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week week before starting work of this section.
 - 1. Attendees: Contractor representative charged with oversight, architect, installer team, window mfr. representative.
 - 2. Review:
 - a. Review substrate condition.
 - b. Installation procedures.
 - c. Tolerances.
 - d. Testing procedures.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component dimensions, anchors, fasteners, glass, and internal drainage.

- C. Shop Drawings: Indicate opening dimensions, framed opening tolerances, affected related work, and installation requirements.
- D. Samples: One corner sections, 12 by 12 inch in size, showing window frame section, mullion section, screen and frame, finished surfaces, and glass units.
- E. Operating Hardware: One sample of each type of operating hardware.
- F. Manufacturer's Certificate: Certify that products of this section meet or exceed specified requirements.
- G. Grade Substantiation: Prior to submitting shop drawings or starting fabrication, submit one of the following showing compliance with specified grade for each window type:
 - 1. Evidence of AAMA Certification.
 - 2. Evidence of WDMA Certification.
 - 3. Evidence of CSA Certification.
 - 4. Test report(s) by independent testing agency itemizing compliance and acceptable to authorities having jurisdiction.
- H. Test Reports: Prior to submitting shop drawings or starting fabrication, submit test report(s) by independent testing agency showing compliance with performance requirements in excess of those prescribed by specified grade.
- I. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.
- J. Installer's qualification statement.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing of type specified and with at least five years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.
- B. Jig, brace, and box the window frame assemblies for transport to minimize flexing of members or joints.

1.08 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F.
- B. Maintain this minimum temperature during and after installation of sealants.

1.09 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a 10-Year period after Date of Substantial Completion.
- C. Manufacturer's Warranty: Provide Commercial 10-Year manufacturer warranty for insulated glass units from seal failure, interpane dusting or misting, and replacement of same. Include coverage for degradation of vinyl color finish. Complete form in Owner's name and register with manufacturer.
- D. Commercial Warranty (manufacturer):
 - 1. 10-Year Warranty.
 - 2. Guarantee windows against defects in materials and workmanship including costs for replacement parts and labor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Vinyl Windows:
 - 1. Milgard; Style Line V250 Series.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 DESCRIPTION

- A. Vinyl Windows: Factory fabricated frame and sash members of extruded, hollow, ultra-violet-resistant, polyvinyl chloride (PVC) with integral color; with factory-installed glazing, hardware, related flashings, anchorage and attachment devices.
1. Configuration: As indicated on drawings.
 - a. Product Type: C - Casement window and FW - Fixed window in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
 2. Color: White.
 3. Openings sized to fit windows with clearance around perimeter of assembly providing necessary space for perimeter seals.
 4. Operable Units: Double weatherstripped.
 5. Framing Members: Fusion welded corners and joints, with internal reinforcement where required for structural rigidity; concealed fasteners.
 6. System Internal Drainage: Drain to exterior side by means of weep drainage network any water entering joints, condensation within glazing channel, or other migrating moisture within system.
 7. Glazing Stops, Trim, Flashings, and Accessory Pieces: Formed of rigid PVC, fitting tightly into frame assembly.
 8. Mounting Flange: Integral to frame assembly, providing weather stop at entire perimeter of frame.
 9. Insect Screens: Tight fitting for operating sash location.
 10. Nailing Fin width: 2-inches.

2.03 PERFORMANCE REQUIREMENTS

- A. Grade: AAMA/WDMA/CSA 101/I.S.2/A440 requirements for specific window type, minimum:
1. Performance Class (PC): LC.
 2. Performance Grade (PG): 25, with minimum design pressure (DP) of 25.06 psf.
 3. Manufacturer's published performance ratings for window types that exceed the minimum in these specifications will be the basis of performance requirements.
- B. Condensation Resistance Factor: CRF of 50, minimum, the lower value of the glass and frame window components and determined in accordance with AAMA 1503.
- C. Overall Thermal Transmittance (U-value): 0.35, maximum, including glazing, measured on window sizes required for this project.
- D. Forced Entry Resistance (FER): Tested to comply with ASTM F588 requirements having at least Grade 10 performance for each required window assembly.
- E. Acoustic Performance: Minimum outdoor-indoor transmission class (OITC) rating of 38, when tested in accordance with ASTM E90 and ASTM E1332.

2.04 COMPONENTS

- A. Glazing: Insulated double pane, annealed glass, clear, low-E coated, argon filled, with glass thicknesses as recommended by manufacturer for specified wind conditions SunCoatMAX Basis of design.
1. Glass Stops: Snap-on PVC glazing bead with color to match sash and frame.
 2. Glazing Tape: Closed cell foam type with double sided adhesive.
 3. Setting Blocks: Manufacturer's standard.
 4. Tempered glass where required by building code and AHJ and in classrooms.
- B. Insect Screens: Aluminum, extruded or roll-formed frame with mitered and reinforced corners; apply screen mesh taut to frame; secure to window with hardware to allow easy removal.
1. Hardware: Manufacturer's standard; quantity as required per screen.
 2. Screen Mesh: Vinyl-coated fiberglass, window manufacturer's 18 x 16 mesh.

- 3. Frame Finish: Manufacturer's standard, color to match window frame and sash color.
- C. Operable Sash Weatherstripping: Wool pile; permanently resilient, profiled to maintain weather seal in accordance with AAMA 701/702.
- D. Fasteners: Stainless steel.
- E. Accessories: Provide related flashings, anchorage and attachment devices as necessary for full assembly.
- F. Sealants for Setting Window Sill Pan Flashing: Provide butyl tape, non-hardening butyl, polyurethane, or silicone sealant; in compliance with ASTM E2112 installation practices.

2.05 HARDWARE

- A. Horizontal Sliding Sash: Rigid PVC interfacing tracks with dual brass wheel and stainless steel axle assembly housing, provide two sets for each operating sash and opening stops in head and sill track as required.
- B. Vertical Sliding Sash: Metal and nylon spiral friction slide cylinder, provide two for each sash and jamb.
- C. Sash lock: Lever handle and keeper with cam lock, provide at least one for each operating sash.
- D. Casement/Awning Sash: Steel rotary arm sash operating mechanism with fold-down handle and two bar adjustable hinges and keepers fitted to projecting sash arms with limit stops.
 - 1. "Tuscany Casement Handle"
- E. Projecting Sash Arms: Cadmium plated steel, friction pivot joints with nylon bearings, removable pivot clips for cleaning.
- F. Projecting Sash Lock: Single lever, multi-point, locking mechanism.
- G. Window Opening Control Devices (WOCD): Provide operable window sash hardware that limits openings to only allow passage of 4 inch diameter rigid sphere or less.
- H. Finish of Exposed Hardware: Baked enamel, match interior sash and frame color.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify wall openings and adjoining water-resistive barrier seal materials are ready to receive this work.

3.02 INSTALLATION

- A. Install window unit assemblies in accordance with manufacturers instructions and applicable building codes.
- B. Install windows in accordance with ASTM E2112.
- C. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities as necessary.
- D. Align window plumb and level, free of warp or twist, and maintain dimensional tolerances and alignment with adjacent work.
- E. Set sill members and sill flashing in continuous bead of sealant.
- F. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- G. Install operating hardware.

3.03 TOLERANCES

- A. Maximum Variation from Level or Plumb: 0.06 inches every 3 ft non-cumulative or 0.5 inches per 100 ft, whichever is less.

3.04 FIELD QUALITY CONTROL

- A. Provide services of vinyl window manufacturer's field representative to observe for proper installation of system and submit report.
- B. See Section 01 4000 - Quality Requirements for independent field testing and inspection requirements, and requirements for monitoring quality of specified product installations.
- C. Provide field testing of installed vinyl windows by independent laboratory in accordance with AAMA 502 and AAMA/WDMA/CSA 101/I.S.2/A440 during construction process and before installation of interior finishes.
 - 1. Perform test sessions on three windows of the largest operable types in designated locations as directed by Architect.
 - 2. Conduct test sessions on individual windows prior to 5 percent, 35 percent, 50 percent, and 90 percent completion of this work.
 - 3. Field test for water penetration in accordance with ASTM E1105 using Procedure B - cyclic static air pressure difference; test pressure shall not be less than 6.24 psf.
 - a. No reduction in test pressure permitted due to field testing.
 - 4. Field test for air leakage in accordance with ASTM E783 with uniform static air pressure difference of 1.57 psf.
 - a. Maximum allowable rate of air leakage is 1.5 times specified rate of 0.10 cfm/sq ft as indicated in AAMA/WDMA/CSA 101/I.S.2/A440.
- D. Repair or replace fenestration components that have failed designated field testing, and retest to verify performance complies with specified requirements. Procedure:
 - 1. Identify the cause of failure.
 - 2. Repair and retest failed window.
 - 3. Repair other windows that exhibit the cause of failure in the test specimen.
 - 4. For each failed window conduct and additional 3 more random tests on the 3 other windows of the same or similar type that failed. This additional testing is to commence as soon as possible and are in addition to the tests indicated at percentage complete stages.

3.05 ADJUSTING

- A. Adjust hardware for smooth operation and secure weathertight closure.

3.06 CLEANING

- A. See Section 01 7419 - Construction Waste Management and Disposal for additional requirements.
- B. Remove protective material from pre-finished surfaces.
- C. Wash surfaces by method recommended and acceptable to window manufacturer; rinse and wipe surfaces clean.
- D. Remove excess glazing sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer and appropriate for application indicated.

END OF SECTION 08 5313

SECTION 08 5659
SERVICE AND TELLER WINDOW UNITS

PART 2 PRODUCTS**1.01 MANUFACTURERS**

- A. Service and Teller Window Units:
 - 1. CR Laurence, Sharyn Model Pass-Thru Window to match existing.

1.02 ASSEMBLY COMPONENTS

- A. Windows: Factory-fabricated, finished, and glazed, with extruded aluminum frame and glazing stops; complete with hardware and anchors.
 - 1. Provide window units that are re-glazable from the secure side without dismantling the non-secure side of framing.
 - 2. Rigidly fit and secure joints and corners with internal reinforcement. Make joints and connections flush, hairline.
 - 3. Factory finish at all exposed surfaces.

PART 3 EXECUTION**2.01 EXAMINATION**

- A. Verify that window openings are ready for installation of windows.

2.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install units in correct orientation (inside/outside).
- C. Anchor units securely in manner so as to achieve performance specified.

END OF SECTION 08 5659

**SECTION 08 7100
DOOR HARDWARE**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Hardware for wood doors.
- B. Seals and door gaskets.

1.02 RELATED REQUIREMENTS

- A. Section 08 1113 - Hollow Metal Door and Window Frames: Hardware Coordination.
- B. Section 08 1416 - Flush Wood Doors: Hardware Coordination.
- C. Sections 08 7101 - Door Hardware Sets: Hardware schedule.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; 2004.
- D. DHI WDHS.3 - Recommended Locations for Architectural Hardware for Flush Wood Doors; 1993; also in WDHS-1/WDHS-5 Series, 1996.
- E. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- F. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware will be installed upon.
- B. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- C. Convey Owner's keying requirements to manufacturers.
- D. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; require attendance by all affected installers.
- E. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project.
- C. Hardware Schedule: Detailed listing of each item of hardware to be installed on each door. Use door numbering scheme as included in the Contract Documents. Identify electrically operated items and include power requirements.
- D. Keying Schedule: Submit for approval of Owner.
- E. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.
- F. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
 - 1. Submit manufacturer's parts lists and templates.
 - 2. Bitting List: List of combinations as furnished.

- G. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.
- H. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- I. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.
- J. Maintenance Materials and Tools: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Tools: One set of all special wrenches or tools applicable to each different or special hardware component, whether supplied by the hardware component manufacturer or not.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B. Hardware Supplier Qualifications: Company specializing in supplying commercial door hardware approved by manufacturer.
- C. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC) to assist in the work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Package hardware items individually; label and identify each package with door opening code to match hardware schedule.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year warranty for standard duty cylindrical (bored) locks and latches.
- C. Provide twenty five year warranty for manual overhead door closer bodies.

PART 2 PRODUCTS

2.01 DOOR HARDWARE - GENERAL

- A. Provide hardware specified or required to make doors fully functional, compliant with applicable codes, and secure to the extent indicated.
- B. Provide items of a single type of the same model by the same manufacturer.
- C. Provide products that comply with the following:
 - 1. Applicable provisions of federal, state, and local codes.
 - 2. Accessibility: ADA Standards and ICC A117.1.
 - 3. ANSI/ICC A117.1, American National Standard for Accessible and Usable Buildings and Facilities.
 - 4. Applicable provisions of NFPA 101, Life Safety Code.
- D. Finishes: Identified in hardware schedule.

2.02 LOCKS AND LATCHES

- A. Locks: Provide a lock for every door, unless specifically indicated as not requiring locking.
 - 1. If no hardware set is indicated for a swinging door provide an office lockset.
 - 2. Trim: Provide lever handle or pull trim on outside of all locks unless specifically stated to have no outside trim.
 - 3. Lock Cylinders: Provide key access on outside of all locks unless specifically stated to have no locking or no outside trim.
- B. Lock Cylinders: Manufacturer's standard tumbler type, six-pin standard core.
 - 1. Provide cams and/or tailpieces as required for locking devices required.
- C. Keying: Grand master keyed.

- D. Latches: Provide a latch for every door that is not required to lock, unless specifically indicated "push/pull" or "not required to latch".

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that doors and frames are ready to receive work; labeled, fire-rated doors and frames are present and properly installed, and dimensions are as indicated on shop drawings.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
B. Use templates provided by hardware item manufacturer.
C. Mounting heights for hardware from finished floor to center line of hardware item.
1. For steel doors and frames: Comply with DHI "Recommended Locations for Architectural Hardware for Steel Doors and Frames."
2. For Wood Doors: Comply with DHI "Recommended Locations for Architectural Hardware for Wood Flush Doors."

3.03 FIELD QUALITY CONTROL

- A. Provide an Architectural Hardware Consultant to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

3.04 ADJUSTING

- A. Adjust work under provisions of Section 01 7000.
B. Adjust hardware for smooth operation.
C. Adjust gasketing and door seals for complete, continuous seal, so that no gaps exist that allow visible light to pass through; replace if unable to make complete seal.

3.05 CLEANING

- A. Clean adjacent surfaces soiled by hardware installation. Clean finished hardware per manufacturer's instructions after final adjustments has been made. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

3.06 PROTECTION

- A. Protect finished Work under provisions of Section 01 7000.
B. Do not permit adjacent work to damage hardware or finish.

3.07 SCHEDULE - ATTACHED

3.08 DOOR HARDWARE SETS

- A. The hardware sets in Section 08 7101 represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
1. Quantities listed are for each pair of doors, or for each single door.
 2. The supplier is responsible for handing and sizing all products.
 3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
 4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

END OF SECTION 08 7100

SECTION 08 8000**GLAZING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Insulating glass units.
- B. Glazing units.

1.02 RELATED REQUIREMENTS

- A. Section 07 2700 - Air Barriers.
- B. Section 08 1113 - Hollow Metal Door and Window Frames: Glazed lites in doors and borrowed lites. Glazing specified in this Section.
- C. Section 08 1416 - Flush Wood Doors: Glazed lites in doors. Glazing specified in this Section.
- D. Section 08 4313 - Aluminum-Framed Storefronts and Doors: Glazing specified in this Section.
- E. Section 08 5313 - Vinyl Windows: Glazing specified in Section 08 5313.
- F. Section 08 8300 - Mirrors.

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015.
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- D. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2019).
- E. ASTM C1036 - Standard Specification for Flat Glass; 2021.
- F. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
- G. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.
- H. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.
- I. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2016.
- J. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.
- K. GANA (GM) - GANA Glazing Manual; 2022.
- L. GANA (SM) - GANA Sealant Manual; 2008.
- M. GANA (LGRM) - Laminated Glazing Reference Manual; 2019.
- N. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use; 1990 (2016).
- O. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2020.
- P. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2020.
- Q. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2023.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data on Insulating Glass Unit, Glazing Unit, Plastic Sheet Glazing Unit, and Plastic Film Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.

- C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Samples: Submit two samples 12 by 12 inch in size of glass units.
- E. Certificate: Certify that products of this section meet or exceed specified requirements.
- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM), GANA (SM), GANA (LGRM), and IGMA TM-3000 for glazing installation methods.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
 - 1. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.
 - a. Insulating Glass Certification Council (IGCC).
 - b. Safety Glazing Certification Council (SGCC).
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.
 - 1. Provide company, field supervisors, and installers that hold active ANSI accredited certifications in appropriate categories for work specified.
 - a. North American Contractor Certification (NACC) for glazing contractors.
 - b. Equivalent independent third-party ANSI accredited certification.
- D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.06 MOCK-UPS

- A. See Section 01 4000 - Quality Requirements for additional requirements.

1.07 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Insulating Glass Units: Provide a ten (10) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including replacement of failed units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Float Glass Manufacturers:
 - 1. AGC Glass Company North America, Inc.
 - 2. Cardinal Glass Industries.
 - 3. Guardian Industries Corp.
 - 4. Pilkington North America.
 - 5. Saint Gobain North America.
 - 6. Vitro Architectural Glass (formerly PPG).
 - 7. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Design Pressure: Calculated in accordance with ASCE 7.
 - 2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 3. Seismic Loads: Design and size glazing components to withstand seismic loads and sway displacement in accordance with the requirements of ASCE 7.
 - 4. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - 5. Glass thicknesses listed are minimum.
- B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
 - 1. In conjunction with weather barrier related materials described in other sections, as follows:
 - a. Air Barriers: See Section 07 2700.
 - 2. To utilize inner pane of multiple pane insulating glass units for continuity of vapor retarder and/or air barrier seal.
 - 3. To maintain a continuous vapor retarder and/or air barrier throughout glazed assembly from glass pane to heel bead of glazing sealant.
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
 - 1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.03 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
 - 2. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.
 - 3. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
 - 4. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
 - 5. Thicknesses: As indicated; provide greater thickness as required for exterior glazing wind load design.

2.04 INSULATING GLASS UNITS

- A. Manufacturers:
 - 1. Glass: Any of the manufacturers specified for float glass.
- B. Fabricator: Certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.
- C. Insulating Glass Units: Types as indicated.
 - 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 - 2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 - 3. Metal-Edge Spacers: Aluminum, bent and soldered corners.

4. Spacer Color: Black.
5. Edge Seal:
 - a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone, polysulfide, or polyurethane sealant as secondary seal applied around perimeter.
6. Color: Black.
7. Purge interpane space with dry air, hermetically sealed.
- D. Type IG-1 - Insulating Glass Units: Vision glass, double glazed.
 1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with air.
 3. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 4. Inboard Lite: Annealed float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 5. Total Thickness: 1 inch.
 6. Thermal Transmittance (U-Value), Winter - Center of Glass: 0.28, maximum.
 7. Visible Light Transmittance (VLT): 60 percent, minimum.
 8. Solar Heat Gain Coefficient (SHGC): .27 percent, maximum.
 9. Visible Light Reflectance, Outside: 13 percent, minimum.
 10. Glazing Method: Dry glazing method, gasket glazing.
 11. Basis of Design: Vitro Architectural Glass Solarban 70 Clear + Clear.
- E. Type IG-2 - Insulating Glass Units: Safety glazing.
 1. Applications:
 - a. Glazed lites in exterior doors.
 - b. Glazed sidelights and panels next to doors.
 - c. Other locations required by applicable federal, state, and local codes and regulations.
 - d. Other locations indicated on drawings.
 2. Space between lites filled with air.
 3. Glass Type: Same as other vision glazing except use fully tempered float glass for both outboard and inboard lites.
 4. Total Thickness: 1 inch.

2.05 GLAZING UNITS

- A. Type G-1 - Monolithic Interior Vision Glazing:
 1. Applications: Interior glazing unless otherwise indicated.
 2. Glass Type: Annealed float glass.
 3. Tint: Clear.
 4. Thickness: 1/4 inch, nominal, or as require for opening size.
- B. Type G-2 - Monolithic Safety Glazing: Non-fire-rated.
 - a. Glazed lites in doors, except fire doors.
 - b. Sliding glass doors.
 - c. Glazed sidelights to doors, except in fire-rated walls and partitions.
 - d. Glazed view windows and panels in partitions enclosing athletic activity rooms, except in fire-rated walls and partitions.
 - e. Other locations required by applicable federal, state, and local codes and regulations.
 - f. Other locations indicated on drawings.
2. Glazing for cabinet doors should have flat polished edges and flat polished edge holes for locks and pulls
3. Glazing Method: Dry glazing method, gasket glazing.

2.06 ACCESSORIES

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.
- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inch long by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.
- C. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.
 - 1. Width: As required for application.
 - 2. Thickness: As required for application.
 - 3. Spacer Rod Diameter: As required for application.
- D. Glazing Gaskets and Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.
- E. Glazing Clips: Manufacturer's standard type.

PART 3 EXECUTION**3.01 VERIFICATION OF CONDITIONS**

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that the minimum required face and edge clearances are being provided.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- D. Verify that sealing between joints of glass framing members has been completed effectively.
- E. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.
- B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- C. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.
- D. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.
- E. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.
- F. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, etc.

3.04 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

- A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.
- B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.
- C. Monitor and report installation procedures and unacceptable conditions.

3.06 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove nonpermanent labels immediately after glazing installation is complete.
- C. Clean glass and adjacent surfaces after sealants are fully cured.
- D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.07 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION 08 8000

SECTION 08 8300**MIRRORS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Glass mirrors.
 - 1. Annealed float glass.

1.02 REFERENCE STANDARDS

- A. ASTM C1036 - Standard Specification for Flat Glass; 2016.
- B. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.
- C. GANA (GM) - GANA Glazing Manual; 2022.
- D. GANA (SM) - GANA Sealant Manual; 2008.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data on Mirror Types: Submit structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM) and GANA (SM) for glazing installation methods.
- B. Fabricate, store, transport, receive, install, and clean mirrors in accordance with manufacturer's recommendations.

1.05 FIELD CONDITIONS

- A. Do not install mirrors when ambient temperature is less than 50 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.06 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for reflective coating on mirrors and replacement of same.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Mirror Design Criteria: Select materials and/or provide supports as required to limit mirror material deflection to 1/200, or to the flexure limit of glass, with full recovery of glazing materials, whichever is less.
- B. Mirror Glass (MI-1), (MI-2): Clear, annealed float glass; ASTM C1036, with copper and silver coatings, and protective overcoating.
 - 1. Thickness: 1/4 inch.
 - 2. Size: As indicated on drawings.

2.02 ACCESSORIES

- A. Mirror Attachment Accessories: Stainless steel J-profile channels.
- B. Mirror Adhesive: Silicone pre-polymer based, chemically compatible with mirror coating and wall substrate.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that openings for mirrored glazing are correctly sized and within tolerance.
- B. Verify that surfaces of mirror frames or recesses are clean, free of obstructions, and ready for installation of mirrors.

3.02 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous mirror frames or recesses with substrate compatible primer or sealer. Prime surfaces scheduled to receive sealant.
- C. Prepare installation in accordance with ASTM C1193 for solvent release sealants, and install sealant in accordance with manufacturer's instructions.

3.03 INSTALLATION

- A. Install mirrors in accordance with manufacturer's recommendations.
- B. Set mirrors plumb and level, and free of optical distortion.
- C. Set mirrors with edge clearance free of surrounding construction including countertops or backsplashes.
- D. Frameless Mirrors: Set mirrors with clips, and anchor rigidly to wall construction.

3.04 CLEANING

- A. Remove wet glazing materials from finish surfaces.
- B. Remove labels after work is complete.
- C. Clean mirrors and adjacent surfaces.

3.05 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste.

END OF SECTION 08 8300

SECTION 09 2116
GYPHUM BOARD ASSEMBLIES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Performance requirements for gypsum board assemblies.
- B. Interior metal stud wall framing.
- C. Acoustic insulation.
- D. Gypsum wallboard.
- E. Joint treatment and accessories.
- F. Textured finish system.

1.02 RELATED REQUIREMENTS

- A. Section 01 3300 - Delegated Design Requirements: Suspended systems engineering. Interior framing engineering.
- B. Section 07 8400 - Firestopping: Top-of-wall assemblies at fire rated walls.
- C. Section 07 9200 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.
- D. Section 09 5100 - Acoustical Ceilings.

1.03 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- B. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2018.
- C. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2017.
- D. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- E. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2020.
- F. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.
- G. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- H. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.
- I. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
- J. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
- K. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).
- L. ASTM E413 - Classification for Rating Sound Insulation; 2022.
- M. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.
- N. UL (FRD) - Fire Resistance Directory; Current Edition.
- O. GA-600 - Fire Resistance and Sound Control Design Manual; 2021.
- P. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

- B. See Section 01 3323 - Shop Drawings, Product Data, Samples
- C. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- D. Test Reports: For stud framing products that do not comply with ASTM C645 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.
- E. Samples: Submit two samples of gypsum board finished with proposed texture application, 12 by 12 inches in size, illustrating finish color and texture.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing gypsum board installation and finishing.
- B. Copies of Documents at Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840, GA-216, GA-600.
- B. Interior Partitions : Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC as indicated calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
 - 1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
 - 2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- D. Fire Rated Assemblies: Provide completed assemblies complying with applicable code.
 - 1. ICC IBC Item Numbers: Comply with applicable requirements of ICC IBC for the particular assembly.
 - 2. Gypsum Association File Numbers: Comply with requirements of GA-600 for the particular assembly.
 - 3. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL Fire Resistance Directory.

2.02 GYPSUM BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 - 1. American Gypsum Company.
 - 2. CertainTeed Corporation.
 - 3. Georgia-Pacific Gypsum.
 - 4. National Gypsum Company.
 - 5. USG Corporation.
 - 6. Substitutions: See Section 01 6000 - Product Requirements.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; Type X board, ends square cut.
 - 1. Application: Use for vertical surfaces, unless otherwise indicated.
 - 2. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
- C. Tile Backing Board:
 - 1. Application: Surfaces behind tile including restrooms.

2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
 - a. Fire Resistant Type: Type X core, thickness 5/8 inch.
 - b. Products:
 - 1) USG Durock Brand Glass-Mat Tile Backerboard.
 - 2) Georgia-Pacific Gypsum; DensShield Tile Backer.
 - 3) National Gypsum Company; Gold Bond eXP Tile Backer.
 - 4) Temple-Inland Building Product by Georgia-Pacific, LLC; GreenGlass Tile Backer.
 - 5) Substitutions: See Section 01 6000 - Product Requirements.
4. Ready-mixed vinyl-based joint compound.
5. Chemical hardening type compound.

2.03 GYPSUM WALLBOARD ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed glass fiber batts, friction fit type, and semi-rigid mineral wool, unfaced.
 1. Applications:
 - a. Glass fiber batts: All interior stud walls to ceiling, unless otherwise noted.
 - b. Semi Rigid mineral wool: Above ceilings where insulation is indicated on drawings.
 - 1) Basis of Design: Rockwool Comfortbatt.
 2. Thickness:
 - a. Glass fiber batts: full cavity unless otherwise noted.
 - b. Semi Rigid mineral wool: full cavity.
 3. Facing: unfaced.
 4. Density:
 - a. Glass fiber batts: 2.5 pcf.
 - b. Semi Rigid mineral wool: 2.0 pcf.
- B. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
 1. Types: As detailed or required for finished appearance.
- C. Paper Faced Gypsum Board: Use paper joint tape, bedded with ready-mixed vinyl-based joint compound and finished with ready-mixed vinyl-based joint compound.
- D. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inch in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion resistant.
- E. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion resistant.
- F. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.
- B. Verify prior to beginning installation that hangers, suspension system, and framing will not interfere with other Work.
- C. Verify prior to beginning installation that other Work is coordinated with suspension system.

3.02 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Above ceilings, secure to studs, if necessary, to prevent insulation from slumping or detaching from stud cavity.

- C. Acoustic Sealant: Install in accordance with manufacturer's instructions.
 - 1. Place one bead continuously on substrate before installation of perimeter framing members.
 - 2. Place continuous bead at perimeter of each layer of gypsum board.
 - 3. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.

3.03 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Non-Rated: At walls, install gypsum board in most economical direction, with ends and edges occurring over firm bearing. At ceilings, install gypsum board at right angles to framing, with ends occurring over firm bearing.
 - 1. Exception: Tapered edges to receive joint treatment at right angles to framing.
- C. Double-Layer Non-Rated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
- D. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- E. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of non-rated double-layer assemblies, which may be installed by means of adhesive lamination.
- F. Moisture Protection: Treat cut edges and holes in moisture resistant gypsum board and exterior gypsum soffit board with sealant.

3.04 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 - 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.

3.05 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 4: Walls and ceilings to receive textured wall finish, paint finish and wall coverings.
 - 2. Level 3: In storage and utility rooms.
 - 3. Level 2: Behind cabinetry, and on backing board to receive tile finish.
 - 4. Level 1: Wall areas above finished ceilings, whether or not accessible in the completed construction. Top and bottom sides of ceiling assemblies not exposed to view.
- C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
 - 2. Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
 - 3. Taping, filling and sanding is not required at base layer of double layer applications.
 - 4. Reinforce joints at high impact boards to prevent failure upon impact.
- D. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.06 TEXTURE FINISH

- A. Applications: All exposed gypsum board walls, except where otherwise noted.

- B. Apply finish texture coating by means of spraying apparatus in accordance with manufacturer's instructions and to match approved sample.
- C. Finish: Match texture of existing walls.
- D. Omit texture behind wall coverings.

3.07 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION 09 2116

**SECTION 09 6500
RESILIENT FLOORING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Resilient sheet flooring.
- B. Resilient tile flooring.
- C. Resilient strip flooring.
- D. Resilient base.
- E. Installation accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 REFERENCE STANDARDS**1.04 SUBMITTALS**

- A. See section 01 3323 - Shop Drawings, Product Data, Samples
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Shop Drawings: Indicate seaming plans and floor patterns.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Flooring Material: 50 square feet of each type and color.

PART 2 PRODUCTS**2.01 SHEET FLOORING**

- A. Reference Finish Schedule.

2.02 TILE FLOORING

- A. Reference Finish Schedule

2.03 PLANK FLOORING

- A. Reference Finish Schedule

2.04 RESILIENT BASE

- A. Reference Finish Schedule

2.05 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
 - 1. VOC Content Limits: As specified in Section 01 6116.
- C. Moldings, Transition and Edge Strips: Same material as flooring.
- D. Filler for Coved Base: Plastic.
- E. Sealer and Wax: Types recommended by flooring manufacturer.

PART 3 EXECUTION**3.01 INSTALLATION - GENERAL**

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.

3.02 INSTALLATION - SHEET FLOORING

- A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.

3.03 INSTALLATION - TILE AND STRIP FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

3.04 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.05 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

3.06 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 09 6500

SECTION 09 6813
TILE CARPETING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Carpet tile, fully adhered.
- B. Removal of existing carpet tile.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 09 0561 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Samples: Submit two carpet tiles illustrating color and pattern design .
- D. Manufacturer's Installation Instructions: Indicate special procedures.
- E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.05 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS**2.01 MATERIALS - TILE GENERAL REQUIREMENTS**

- A. VOC Content: Provide CRI Green Label Plus certified product; in lieu of labeling, independent test report showing compliance is acceptable.
- B. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
- C. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

2.02 MATERIALS - CARPET TYPES

- A. Reference Finish Schedule

2.03 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.
- B. Adhesives:
 - 1. Compatible with materials being adhered; maximum VOC content as specified in Section 01 6116.
- C. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

- B. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.
- C. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Remove existing carpet tile.
- B. Prepare floor substrates for installation of flooring in accordance with Section 09 0561.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Trim carpet tile neatly at walls and around interruptions.
- F. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION 09 6813

SECTION 09 8430
SOUND-ABSORBING WALL AND CEILING UNITS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Sound-absorbing panels.
- B. Mounting accessories.

1.02 REFERENCE STANDARDS**1.03 SUBMITTALS**

- A. See Section 02 3323 - Shop Drawings, Product Data, Samples
- B. Product Data: Manufacturer's printed data sheets for products specified.
- C. Shop Drawings: Fabrication and installation details, panel layout, fabric orientation, and wood grain orientation.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Panels: Quantity equal to 5 percent of total installed, but not less than one of each type.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect acoustical units from moisture during shipment, storage, and handling. Deliver in factory-wrapped bundles; do not open bundles until units are needed for installation.
- B. Store units flat, in dry, well-ventilated space; do not stand on end.
- C. Protect edges from damage.

PART 2 PRODUCTS**2.01 SOUND-ABSORBING UNITS**

- A. Reference Finish Schedule

2.02 FABRICATION

- A. Custom-shaped "Tree" acoustic wall and ceiling panels. See drawings.

2.03 ACCESSORIES

- A. Back-Mounting Accessories: Manufacturer's standard accessories for concealed support, designed to allow panel removal, and as follows:
- B. Furring Strips: As indicated on drawings.
- C. Panel Adhesive: Acceptable to acoustical panel manufacturer for application as indicated.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install acoustical units in locations as indicated, following manufacturer's installation instructions.
- B. Install mounting accessories and supports in accordance with shop drawings.

3.02 CLEANING

- A. Clean sound-absorptive panels upon completion of installation from dust and other foreign materials, following manufacturer's instructions.

3.03 PROTECTION

- A. Provide protection of installed acoustical panels until Date of Substantial Completion.

B. Replace panels that cannot be cleaned and repaired to satisfaction of the Architect.

END OF SECTION 09 8430

SECTION 09 9113
EXTERIOR PAINTING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Surface preparation.
- B. Field application of paints.
- C. Materials for backpriming woodwork.
- D. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Mechanical and Electrical:
 - a. On the roof and outdoors, paint equipment exposed to weather or to view, including factory-finished materials.
- E. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 - 5. Non-metallic roofing and flashing.
 - 6. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, zinc, and lead.
 - 7. Marble, granite, slate, and other natural stones.
 - 8. Floors, unless specifically indicated.
 - 9. Ceramic and other types of tiles.
 - 10. Brick, glass unit masonry, architectural concrete, cast stone, integrally colored plaster and stucco.
 - 11. Glass.
 - 12. Concrete.
 - 13. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 05 5000 - Metal Fabrications: Shop-primed items.
- C. Section 09 9123 - Interior Painting.
- D. Section 09 3000 - Staining and Transparent Finishing.

1.03 DEFINITIONS

- A. Comply with ASTM D16 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS

- A. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2019.
- B. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating; 2005 (Reapproved 2017).
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2020.

- D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.
- E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.
- F. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- G. SSPC-SP 2 - Hand Tool Cleaning; 2018.
- H. SSPC-SP 6 - Commercial Blast Cleaning; 2007.
- I. SSPC-SP 13 - Surface Preparation of Concrete; 2018.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).
 - 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
 - 4. Manufacturer's installation instructions.
 - 5. If proposal of substitutions is allowed under submittal procedures, explanation of substitutions proposed.
- C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
 - 1. Where sheen is specified, submit samples in only that sheen.
 - 2. Where sheen is not specified, discuss sheen options with Architect before preparing samples, to eliminate sheens not required.
 - 3. Allow 30 days for approval process, after receipt of complete samples by Architect.
 - 4. Paint color submittals will not be considered until color submittals for major materials not to be painted, such as masonry, have been approved.
- D. Manufacturer's Instructions: Indicate special surface preparation procedures.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Paint and Finish Materials: 1 gallon of each color; from the same product run, store where directed.
 - 3. Label each container with color in addition to the manufacturer's label.

1.06 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 5 years experience and approved by manufacturer.

1.07 MOCK-UPS

- A. See Section 01 4000 - Quality Requirements, for general requirements for mock-up.
- B. Refer to Section 09 9123 - Interior Painting, for mock-up requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.09 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the paint product manufacturer's temperature ranges.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply exterior paint and finishes during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- D. Minimum Application Temperatures for Latex Paints: 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Provide paints and finishes from the same manufacturer to the greatest extent possible.
 - 1. Substitution of MPI-approved products by a different manufacturer is preferred over substitution of unapproved products by the same manufacturer.
 - 2. Substitution of a different paint system using MPI-approved products by the same manufacturer will be considered.
- B. Paints:
 - 1. Benjamin Moore & Co.
 - 2. Glidden Professional.
 - 3. Rodda Paint Company.
 - 4. Sherwin-Williams Company.
 - 5. Miller Paint.
 - 6. PPG Paints.
- C. Primer Sealers: Same manufacturer as top coats.
- D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless required to be a field-catalyzed paint.
 - 1. Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI categories, except as otherwise indicated.
 - 2. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 3. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - 4. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
 - 5. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 6. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is described explicitly in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content: Comply with Section 01 6116.
- C. Flammability: Comply with applicable code for surface burning characteristics.
- D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- E. Colors: As indicated in Color Schedule.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Paint E-OP-LExterior Surfaces to be Painted, Unless Otherwise Indicated: Including fiber cement siding and primed wood.
 - 1. Two top coats and one coat primer.
 - 2. Top Coat(s): Exterior Latex, High Performance Architectural; MPI #311 or 315.
 - 3. Primer: As specified under "PRIMERS" below.
- B. Paint ME-OP-2A - Ferrous Metals, Primed, Alkyd, 2 Coat: Applications include exterior hollow metal doors and frames and other exterior pre-primed metals.
 - 1. Note: There should be no ferrous metals exterior to the building or penetrating from the interior of the building to the exterior, that is not galvanized, stainless, or powder coated. Notify Architect of any discrepancies prior to fabrication.
 - 2. Prime with Zinc-Rich rust-inhibitive primer recommended by top coat manufacturer.
 - 3. Semi-gloss: Two coats of alkyd enamel; MPI #94.
- C. Paint MgE-OP-3A - Galvanized Metals, Alkyd, 3 Coat:
 - 1. One coat galvanize primer.
 - 2. Semi-gloss: Two coats of alkyd enamel; MPI #94.

2.04 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.
 - 1. Alkali Resistant Water Based Primer; MPI #3.
 - 2. Zinc-Rich, Inorganic, Primer for Ferrous Metal; MPI #19.
 - 3. Water Based Primer for Galvanized Metal; MPI #134.
 - 4. Latex Primer for Exterior Wood; MPI #6.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Do not begin application of paints and finishes until substrates have been properly prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Test shop-applied primer for compatibility with subsequent cover materials.
- F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Exterior Plaster and Stucco: 12 percent.
 - 2. Fiber Cement Siding: 12 percent.
 - 3. Exterior Wood: 15 percent, measured in accordance with ASTM D4442.
 - 4. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Concrete:
 - 1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 2. Clean surfaces with pressurized water. Use pressure range of 1,500 to 4,000 psi at 6 to 12 inches. Allow to dry.
 - 3. Clean concrete according to ASTM D4258. Allow to dry.
 - 4. Prepare surface as recommended by top coat manufacturer and according to SSPC-SP 13.
- G. Fiber Cement Siding: Remove dirt, dust and other foreign matter with a stiff fiber brush. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
- H. Exterior Gypsum Board: Fill minor defects with exterior filler compound. Spot prime defects after repair.
- I. Exterior Plaster: Fill hairline cracks, small holes, and imperfections with exterior patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- J. Asphalt, Creosote, or Bituminous Surfaces: Remove foreign particles to permit adhesion of finishing materials. Apply latex based sealer or primer.
- K. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
- L. Concrete Floors and Traffic Surfaces: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
- M. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- N. Copper: Remove contamination by steam, high pressure water, or solvent washing.
- O. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 - 2. Prepare surface according to SSPC-SP 2.
- P. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
 - 3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 Commercial Blast Cleaning. Protect from corrosion until coated.
- Q. Exterior Wood Surfaces to Receive Opaque Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior caulking compound after prime coat has been applied. Back prime concealed surfaces before installation.
- R. Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with tinted primer.
- S. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

- B. Exterior Wood to Receive Opaque Finish: If final painting must be delayed more than 2 weeks after installation of woodwork, apply primer within 2 weeks and final coating within 4 weeks.
- C. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- D. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- E. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- F. Apply each coat to uniform appearance.
- G. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply additional coats until complete hide is achieved.
- H. Sand wood and metal surfaces lightly between coats to achieve required finish.
- I. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- J. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 9113

SECTION 09 9123
INTERIOR PAINTING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Surface preparation.
- B. Field application of paints.
- C. Materials for backpriming woodwork.
- D. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
 - 1. Existing and new painted building components on all levels of the building.
 - 2. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 3. Elevator pit ladders.
 - 4. Surfaces inside cabinets.
 - 5. Prime surfaces to receive wall coverings.
 - 6. Mechanical and Electrical:
 - a. In finished areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
 - b. In finished areas, paint shop-primed items.
 - c. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
 - d. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- E. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, and lead items.
 - 6. Marble, granite, slate, and other natural stones.
 - 7. Floors, unless specifically indicated.
 - 8. Ceramic and other tiles.
 - 9. Brick, architectural concrete, cast stone, integrally colored plaster, and stucco.
 - 10. Glass.
 - 11. Concrete.
 - 12. Acoustical materials, unless specifically indicated.
 - 13. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- A. Interior Finish Schedule on Drawings.
- B. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Section 09 9113 - Exterior Painting.
- D. Section 09 9600 - High-Performance Coatings.

1.03 DEFINITIONS

- A. Comply with ASTM D16 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS

- A. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2019.
- B. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating; 2005 (Reapproved 2017).
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2020.
- D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.
- E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.
- F. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- G. SSPC-SP 2 - Hand Tool Cleaning; 2018.
- H. SSPC-SP 6 - Commercial Blast Cleaning; 2007.
- I. SSPC-SP 13 - Surface Preparation of Concrete; 2018.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 - 2. MPI product number (e.g., MPI #47).
 - 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system. Indicate primer to be used in each substrate; show the source of the manufacturer's recommendation for each primer to be used on each substrate, for each top-coat.
 - 4. Manufacturer's installation instructions.
 - 5. If proposal of substitutions is allowed under submittal procedures, explanation of substitutions proposed.
- C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
 - 1. Where sheen is specified, submit samples in only that sheen.
 - 2. Where sheen is not specified, discuss sheen options with Architect before preparing samples, to eliminate sheens not required.
 - 3. Allow 30 days for approval process, after receipt of complete samples by Architect.
 - 4. Paint color submittals will not be considered until color submittals for major materials not to be painted, such as masonry, have been approved.
- D. Samples: Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded. Submit on tempered hardboard, 8x12 inch in size.
- E. Manufacturer's Instructions: Indicate special surface preparation procedures.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Paint and Finish Materials: 1 gal of each color; from the same product run, store where directed.
 - 3. Label each container with color in addition to the manufacturer's label.

1.06 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 5 years experience and approved by manufacturer.

1.07 MOCK-UP

- A. See Section 01 4000 - Quality Requirements, for general requirements for mock-up.
- B. Eight weeks prior to the required time to order paint, with ample consideration for lead times, provide draw down samples of specified colors and preliminary colors selected by Architect. At a pre-Installation conference at a regular job meeting with the Painting Subcontractor and the General Contractor, the Architect will select up to 4 colors to be mocked up at a larger scale on similar substrates as the final built condition. Substrates to be provided by Contractor. At the discretion of the Architect these may be the actual surfaces in the project, or they may be sample panels or elements.
 - 1. Provide panel, 4 feet long by 4 feet wide, illustrating paint color, texture, and finish.
 - 2. Based on review of draw downs and large samples provide Architect may select up to 4 more colors to be mocked up at the 4' x 4' size for final selection.
 - 3. Architect will issue a final color schedule substantially similar to the one at end of this Section to serve as a basis for the Work. Architect will clarify detailed locations of color "breaks" and color types and locations, as requested by Contractor, where clarification is needed.
- C. Provide door and frame assembly illustrating paint color, texture, and finish.
- D. Locate where directed by Architect.
- E. Mock-up may remain as part of the work.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.09 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F above the dew point, or to damp or wet surfaces.
- D. Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 fc measured mid-height at substrate surface.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Provide paints and finishes from the same manufacturer to the greatest extent possible.
 - 1. If a single manufacturer cannot provide specified products; minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
 - 2. Substitution of MPI-approved products by a different manufacturer is preferred over substitution of unapproved products by the same manufacturer.

3. Substitution of a different paint system using MPI-approved products by the same manufacturer will be considered.
- B. Paints:
1. Behr Process Corporation.
 2. Benjamin Moore & Co.
 3. Cloverdale Paint, Brand Products of Rodda Paint Company.
 4. Glidden Professional, a product of PPG Architectural Coatings.
 5. Miller Paint.
 6. PPG Paints.
 7. Rodda Paint Co.
 8. Sherwin-Williams Company.
 9. Vista Paint Corporation.
 10. Valspar Corporation.
- C. Primer Sealers: Same manufacturer as top coats.
- D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
1. Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI categories, except as otherwise indicated.
 2. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 3. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 4. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
 5. Supply each paint material in quantity required to complete entire project's work from a single production run.
 6. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content: See Section 01 6116.
- C. Flammability: Comply with applicable code for surface burning characteristics.
- D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- E. Colors: As indicated on drawings.
1. Selection to be made by Architect after award of contract.
 2. Allow for minimum of three colors for each system, unless otherwise indicated, without additional cost to Owner.
 3. Extend colors to surface edges; colors may change at any edge as directed by Architect.
 4. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling they are mounted on/under, unless noted otherwise.
 5. In utility areas, finish equipment, piping, conduit, and exposed duct work in colors according to the color schedule.

2.03 PAINT SYSTEMS - INTERIOR

- A. Paint I-OP - "Interior Opaque" Surfaces to be painted, vertical and overhead, unless otherwise indicated: Including gypsum board, concrete, concrete masonry units, brick, wood, plaster, uncoated steel, shop primed steel, galvanized steel, and aluminum.

1. Two top coats and one coat primer.
 2. Top Coat(s): High Performance Architectural Interior Latex; MPI #140 and #143.
 3. Top Coat Sheen:
 - a. Flat: MPI gloss level 1; use this sheen for ceilings and other overhead surfaces.
 - b. Satin: MPI gloss level 4; use this sheen at all locations unless otherwise indicated.
 4. Primer: As recommended by top coat manufacturer for specific substrate.
- B. Paint I-OP-MD-DT - "Interior Opaque Medium-Duty Door/Trim": For surfaces subject to frequent contact by occupants, including metals and wood:
1. Applications include doors, door frames, railings, handrails, guardrails, and other painted metal in the "touch range".
 2. Two top coats and one coat primer.
 3. Top Coat(s): Interior Light Industrial Coating, Water Based; MPI #153 or 154.
 4. Primer: As recommended by top coat manufacturer for specific substrate.

2.04 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been adequately prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Test shop-applied primer for compatibility with subsequent cover materials.
- F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
 1. Gypsum Wallboard: 12 percent.
 2. Plaster and Stucco: 12 percent.
 3. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
 4. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
 5. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or repair existing paints or finishes that exhibit surface defects.
- D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- E. Seal surfaces that might cause bleed through or staining of topcoat.
- F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- G. Concrete:
 1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

2. Clean surfaces with pressurized water. Use pressure range of 1,500 to 4,000 psi at 6 to 12 inches. Allow to dry.
 3. Clean concrete according to ASTM D4258. Allow to dry.
 4. Prepare surface as recommended by top coat manufacturer and according to SSPC-SP 13.
- H. Masonry:
1. Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
 2. Prepare surface as recommended by top coat manufacturer.
 3. Clean surfaces with pressurized water. Use pressure range of 600 to 1,500 psi at 6 to 12 inches. Allow to dry.
- I. Concrete Floors and Traffic Surfaces: Remove contamination, acid etch and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
- J. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- K. Plaster: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high-alkali surfaces.
- L. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- M. Galvanized Surfaces:
1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 2. Prepare surface according to SSPC-SP 2.
- N. Ferrous Metal:
1. Solvent clean according to SSPC-SP 1.
 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
 3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 Commercial Blast Cleaning. Protect from corrosion until coated.
- O. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- P. Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with clear sealer.
- Q. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- C. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- E. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- F. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- G. Sand wood and metal surfaces lightly between coats to achieve required finish.
- H. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

- I. Wood to Receive Transparent Finishes: See Section 09 9300.
- J. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
- K. Acoustic Decking: Do not allow paint to fill holes.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 9123

SECTION 10 1400
SIGNAGE

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Room and door signs.
- B. Interior directional and informational signs.
- C. Emergency evacuation maps.

1.02 REFERENCE STANDARDS**1.03 SUBMITTALS**

- A. See Section 01 3323 - Shop Drawings, Product Data, Samples
- B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
- C. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
 - 1. When room numbers to appear on signs differ from those on drawings, include the drawing room number on schedule.
 - 2. When content of signs is indicated to be determined later, request such information from Owner through Architect _____; upon request, submit preliminary schedule.
 - 3. Submit for approval by Owner through Architect prior to fabrication.
- D. Samples: Submit two samples of each type of sign, of size similar to that required for project, illustrating sign style, font, and method of attachment.
- E. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.

PART 2 PRODUCTS**2.01 SIGNAGE APPLICATIONS**

- A. Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1 _____, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.
- B. Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.
- C. Interior Directional and Informational Signs:
- D. Emergency Evacuation Maps:

2.02 ACCESSORIES

- A. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION**3.01 EXAMINATION**

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

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install neatly, with horizontal edges level.

- C. Locate signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.

END OF SECTION 10 1400

SECTION 10 2600
WALL AND DOOR PROTECTION

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Corner guards.

1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Blocking for wall and corner guard anchors.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS**2.01 PRODUCT TYPES**

- A. Corner Guards - Surface Mounted:
 - 1. Material: Type 304 stainless steel, No. 4 finish, 16 gage.
 - 2. Width of Wings: 3-1/2 inches.
 - 3. Corner: Square.
 - 4. Length: full height from top of base trim, to underside of ceiling.
 - 5. Screws, predrilled holes by manufacturer. Ensure screw head flush with steel plate.
- B. Mounting with corner guard manufacturer screws with heads design to seat flush with the guard.
- C. See Section 06 1000 for wood blocking for wall and corner guard anchors.

2.02 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Start of installation constitutes acceptance of project conditions.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.
- B. Position corner guard 4 inches above finished floor to ceiling.

END OF SECTION 10 2600

SECTION 10 2800
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Commercial toilet accessories.
- B. Under-lavatory pipe supply covers.
- C. Electric hand/hair dryers.
- D. Diaper changing stations.
- E. Utility room accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry or 09 2116 Gypsum Board Assemblies.: Concealed supports for accessories, including in wall framing and plates and above ceiling framing.
- B. Section 09 2116 - Gypsum Board Assemblies: Attachment backing for accessories.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures; 2011 (Reaffirmed 2022).
- C. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping; 2021.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
- E. ASTM F2285 - Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use; 2022.
- F. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015.
- G. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
- C. Samples: Submit one samples of each accessory, illustrating color and finish.
- D. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS**2.01 COMMERCIAL TOILET ACCESSORIES**

- A. (TPD-1) Toilet Paper Dispenser: Double roll, surface mounted, for coreless type rolls.
 - 1. Georgia Pacific. Compact Side by Side
 - a. Substitutions: Section 01 6000 - Product Requirements.
- B. (TPD-3) Toilet Paper Dispenser: Child toilet rooms
 - 1. Bradley, 508-32 Single Roll
 - a. Substitutions: Section01 6000-Product Requirements.

- C. (SND-1) Sanitary Napkin Dispensing
 - 1. Hospeco EVNT4 No-Touch
 - a. Substitutions: Section01 6000-Product Requirements.
- D. (SND-2) Sanitary Napkin Receptacle
 - 1. Rubbermaid 6140
 - a. Substitutions: Section01 6000-Product Requirements.
- E. (H-1) Hook
 - 1. Bradex 9124 Double Robe Hook
- F. (CHNG-1) Baby Changing Station
 - 1. Koala Care KB300 Baby Changing Stations
- G. (SD-1) Soap Dispenser
 - 1. GOJO FMX-12
 - a. Substitutions: Section01 6000-Product Requirements.
- H. (PTD-1) Paper Towel Dispenser
 - 1. Georgia Pacific, Pacific Blue Ultra Mechanical Towel Dispenser
 - a. Substitutions: Section01 6000-Product Requirements.
- I. (MI-3) Mirror - Child lav.
 - 1. Azzuri, AVON-M24, Circular Mirror
 - a. Substitutions: Section01 6000-Product Requirements.
- J. (SCD-1) Seat Cover Dispenser: _____, surface-mounted, reloading by hinged front panel.
 - 1. Minimum capacity: 250 seat covers.
 - 2. Products:
 - a. GP Pro. Georgia Pacific. White.
 - b. Substitutions: Section 01 6000 - Product Requirements.
- K. (PAR) Toilet Room Partition Door
 - 1. Bobrick 1080 Kiddie.
 - 2. See Finish Schedule for color.
- L. (GB-18, GB-36, GB-48) Grab Bars: Stainless steel, nonslip grasping surface finish.
 - 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force, minimum.
 - b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, concealed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
 - c. Length and Configuration: As indicated on drawings.
 - d. Products: Bobrick B-5806.
 - 1) Substitutions: Section 01 6000 - Product Requirements.

2.02 UNDER-LAVATORY PIPE AND SUPPLY COVERS

- A. Under-Lavatory Pipe and Supply Covers:
 - 1. Insulate exposed drainage piping, including hot, cold, and tempered water supplies under lavatories or sinks to comply with ADA Standards.
 - 2. Exterior Surfaces: Smooth non-absorbent, non-abrasive surfaces.
 - 3. Construction: 1/8 inch flexible PVC.
 - a. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - b. Comply with ASTM C1822, type indicated.
 - c. Comply with ASME A112.18.9.
 - d. Comply with ICC A117.1.
 - e. Microbial and Fungal Resistance: Comply with ASTM G21.
 - 4. Color: White.
 - 5. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces.

2.03 DIAPER CHANGING STATIONS

- A. Diaper Changing Station: Wall-mounted folding diaper changing station for use in commercial toilet facilities, meeting or exceeding ASTM F2285.
 - 1. Material: Polyethylene.
 - 2. Mounting: Surface.
 - 3. Color: Gray.
 - 4. Minimum Rated Load: 250 pounds.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.
- D. Verify that field measurements are as indicated on drawings.
- E. Coordinate with other sections for the installation of blocking, reinforcement plates, and concealed anchors in walls, ceilings, and floors.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

END OF SECTION 10 2800

SECTION 10 4400
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.

1.02 REFERENCE STANDARDS

- A. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.

1.03 SUBMITTALS

- A. See Section 01 3323 - Shop Drawings, Product Data, Samples
- B. Product Data: Provide extinguisher operational features.

PART 2 PRODUCTS**2.01 FIRE EXTINGUISHERS**

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.

2.02 FIRE EXTINGUISHER CABINETS

- A. Cabinet Configuration: Semi-recessed type.
- B. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- C. Door Glazing: Acrylic plastic, clear, 1/8 inch thick, flat shape and set in resilient channel glazing gasket.
- D. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- E. Fabrication: Weld, fill, and grind components smooth.
- F. Finish of Cabinet Exterior Trim and Door: No.4 - Brushed stainless steel.
- G. Finish of Cabinet Interior: White colored enamel.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.

END OF SECTION 10 4400

**SECTION 11 3013
RESIDENTIAL APPLIANCES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Kitchen appliances.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. See Section 01 3323 - Shop Drawings, Product Data, Samples
- C. Product Data: Manufacturer's data indicating dimensions, capacity, and operating features of each piece of residential equipment specified.

PART 2 PRODUCTS

2.01 KITCHEN APPLIANCES

- A. Schedule TBD

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

END OF SECTION 11 3013

SECTION 12 2400
WINDOW SHADES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Interior manual roller shades.

1.02 REFERENCE STANDARDS**1.03 SUBMITTALS**

- A. See Section 01 3323 - Shop Drawings, Product Data, Samples
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
- C. Selection Samples: Include fabric samples in full range of available colors and patterns.
- D. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Interior Manually Operated Window Shades:
 - 1. Match existing: Norman Cordless Cellular Blinds

2.02 ROLLER SHADES

- A. General:
 - 1. Provide shade system components that are easy to remove or adjust without removal of mounted shade brackets.
 - 2. Provide shade system that operates smoothly when shades are raised or lowered.

2.03 SHADE FABRIC

- A. Fabric - Type ____: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
- B. Fabric: Reference Finish Schedule

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.
- B. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.02 CLEANING

- A. Clean soiled shades and exposed components as recommended by manufacturer.
- B. Replace shades that cannot be cleaned to "like new" condition.

3.03 PROTECTION

- A. Protect installed products from subsequent construction operations.

END OF SECTION 12 2400

**SECTION 12 3600
COUNTERTOPS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Countertops for architectural cabinet work.
- B. Wall-hung counters and vanity tops.

1.02 REFERENCE STANDARDS**1.03 SUBMITTALS**

- A. See Section 01 3323 - Shop Drawings, Product Data, Samples
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- C. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.

PART 2 PRODUCTS**2.01 COUNTERTOPS**

- A. Reference Finish Schedule

2.02 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 - 1. Join lengths of tops using best method recommended by manufacturer.
 - 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 - 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 - 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 - 2. Height: 4 inches, unless otherwise indicated.
- C. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B. Seal joint between back/end splashes and vertical surfaces.

3.02 CLEANING**3.03 PROTECTION**

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 12 3600

**SECTION 21 0500
COMMON WORK RESULTS FOR FIRE SUPPRESSION**

PART 1 GENERAL

1.01 SUMMARY

- A. The intent of this Division's Specifications and Drawings is to provide a complete and workable facility, with complete systems as required by applicable codes, as indicated, and as specified.
- B. Provide a complete and workable facility with complete systems that comply with the requirements of the state codes, local codes, fire marshal, Owner's insurance underwriter, and other authorities having jurisdiction. Include design, labor and materials required to install, test and place into operation the systems as called for in the Contract Documents and according to applicable codes and regulations.
- C. Specifications and the accompanying Drawings are complementary and what is called for by one is as binding as if called for by both.
- D. Piping and sprinkler head locations indicated in the accompanying Drawings are provided to meet the Architectural design intent for the building in addition to applicable code. The right is reserved to make any reasonable changes in sprinkler head locations prior to roughing-in, without cost impact. Deviation from the general routing piping mains, standpipes, or other routing shown must be approved by the Architect prior to installation. If additional space is required for fire protection system components, make a formal request prior to installation.
- E. Furnish piping, pipe fittings, valves, gauges, and incidental related items as required for complete systems. Identify valves, piping, and equipment components to indicate their function and system served.
- F. The General and Supplemental Conditions apply to this Division, including but not limited to:
 - 1. Drawings and Specifications.
 - 2. Public ordinances and permits.
 - 3. Payments and fees required by governing authorities for work of this Division.
- G. The Drawings that accompany this Division are diagrammatic. They do not show every offset, bend, tee, or elbow, which may be required to install work in the space provided and avoid conflicts with other construction.
- H. Offsets and transitions are to be assumed at a minimum at each crossing of services, structural penetrations through shear walls or beams, structural grids, where ceiling heights are restricted, and at piping and conduit mains.
- I. Follow the Drawings as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions, and without additional cost to the Owner. Significant deviations from the routing shown on the drawings is subject for approval prior to installation. The right is reserved by the design team to make reasonable changes in locations of system components prior to roughing-in, without cost impact.
- J. Verify dimensions, field conditions, quantities, and measurements prior to installing work.
- K. Work done under this Division of the specifications includes the furnishing of labor, material, equipment, and tools required for the complete installation of the work indicated on the Drawings or as specified herein.
- L. Work installed contrary to Drawings and Specifications is subject to change as directed by the Owner and no extra compensation will be allowed for making those changes.

1.02 PRICE AND PAYMENT PROCEDURES

- A. Allowances:
 - 1. Comply with Division 01, General Requirements.
- B. Alternates:

1. Comply with Division 01, General Requirements.
2. Refer to Drawings for detailed information relating to the appropriate alternates.

1.03 RELATED REQUIREMENTS

- A. Section 21 0548 - Vibration and Seismic Controls for Fire Suppression Piping and Equipment.
- B. Section 21 1300 - Fire-Suppression Sprinkler Systems.

1.04 REFERENCE STANDARDS

- A. Refer to individual sections under this Division for applicable reference standards.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Review Drawings of other trades and Owner provided equipment to avoid conflicts.
 2. Report potential conflicts to Architect, provide resolution prior to rough-in.
 3. Architectural Drawings take precedence regarding exact placement of system components and equipment.
 4. Verify the physical dimensions of equipment to fit the space available.
 5. Coordinate access routes through the construction, equipment move-in planning, and provide all required equipment, transport and services necessary to facilitate installation of equipment.
 6. Where connections are required for equipment provided as Work of other Divisions, coordinate rough in and connection requirements for that equipment with its supplier and installer prior to commencing work.
 7. Notify Architect of any discrepancies between the actual rough in and connection requirements, and those identified on Drawings for resolution prior to installation.
 8. Coordinate underground work with other trades working on the site.
 - a. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained.
 9. Coordinate installation of required supporting devices and set sleeves in architectural and structural components as they are constructed.
 10. Coordinate location of access panels and doors for items concealed behind finished surfaces with Architect.
 11. Coordinate sleeve selection and application with firestopping specified elsewhere.
 12. Finishes: Coordinate with Architect, finish to match surrounding surfaces.
- B. Permits:
 1. Obtain permits and inspections for the installation of work and pay charges required. Deliver certificates of inspection issued by authorities to the Owner.

1.06 SUBMITTALS

- A. General Submittal Requirements:
 1. Refer to Division 00 and Division 01 for general submittal requirements.
 2. Requirements set forth in this Section pertain to all specifications included in this Division of work.
- B. Pre-Bid Submittal Requirements:
 1. Submit Questions and Substitution Requests before the Questions deadline, defined in Division 00 and Division 01.
- C. Bid Submittal Requirements:
 1. Refer to individual Division sections for specific requirements due with Bid.
- D. Contractor Responsibilities:
 1. Provide submittals one time and organized in proper order.
 2. Indicate deviations from Drawings and Specifications explicitly in the submittals.
 3. Failure to comply will void review automatically.

E. Submittal Schedule:

1. General:
 - a. Submit a schedule that is coordinated with the project construction schedule.
 - b. Allow for time required for review of submittals, making corrections/revisions to submittals, ordering, manufacturing, fabrication, and delivery.
2. Submittal Schedule to include the following for each submittal as a minimum:
 - a. Identify submittal by specification section number and title.
 - b. Date the item will be submitted. Arrange items in chronological order by scheduled date for first submittal.
 - c. Identify critical submittals and long lead items explicitly.
 - d. Submittal Category:
 - 1) Product Data
 - 2) Coordination Drawings
 - 3) Shop Drawings
 - 4) Samples
 - 5) Certificates
 - 6) Delegated Design Submittals
 - 7) Test and Evaluation Reports
 - 8) Manufacturers' Instructions
 - 9) Source Quality Control
 - 10) Site Quality Control
 - 11) Manufacturer Reports
 - 12) Sustainable Design
 - 13) Qualification Statements
 - e. Closeout Submittal Category:
 - 1) Maintenance Contracts
 - 2) Operations and Maintenance Data
 - 3) Bonds
 - 4) Warranty Documentation
 - 5) Final Test and Evaluation Reports
 - 6) Record Documentation
 - 7) Demonstration and Training
 - 8) Sustainable Design Closeout
 - 9) Software

F. Product Data:

1. General:
 - a. Assemble complete submittal package for this Division into a single submittal:
 - 1) Partial submittals not accepted.
 - b. Submit product data on following equipment for review:
 - 1) Equipment scheduled on Drawings.
 - 2) Equipment requiring electrical connections or connections by other trades.
 - 3) As required by each specification section or by notes on the Drawings.
2. Format:
 - a. Electronic: Submit electronic copies for Work of this Division in PDF format.
 - 1) Include a complete index in the original submittal.
 - (a) Incorporate links enabling navigation to each item.
 - (b) Identify with each item filed under a folder and labeled with its respective specification section number, Article, and paragraph.
 - 2) Provide cover sheet for each applicable section number.
3. Include for each item as a minimum:

- a. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified.
 - b. Manufacturer's detailed shop drawings including clearances required.
 - c. Manufacturer's detailed specifications.
 - d. Manufacturer's data sheets including capacities, operating speeds, power requirements, design and operating conditions, performance curves, characteristics scheduled or described on the Drawings, and similar data.
 - e. List the name of the motor manufacturer and service factor for each piece of equipment.
 - f. Indicate equipment operating weights including bases and weight distribution at support points.
 - g. Wiring diagrams showing factory installed wiring.
- G. Coordination Drawings:
- 1. General:
 - a. Assemble complete submittal package for the project into a minimum of two submittals:
 - 1) Coordination Drawings - Below Grade
 - 2) Coordination Drawings - Above Grade
 - b. Prepare project-specific information, drawn accurately to scale.
 - c. Submit coordination drawings for review prior to beginning fabrication.
 - d. Sheet Size: Match sheet size of Construction Drawings.
 - e. Prepare in three-dimensional format utilizing the same digital data software program, version, and operating system utilized to develop the Construction Drawings.
 - 2. Format:
 - a. Electronic: Submit electronic copies in PDF format.
 - 3. Include as a minimum:
 - a. Color code and overlay shop drawings for each trade:
 - 1) Structural
 - 2) Civil
 - 3) Ceiling Systems
 - 4) HVAC Equipment
 - 5) HVAC Ductwork
 - 6) HVAC Piping
 - 7) Plumbing Equipment
 - 8) Plumbing Piping
 - 9) Fire Suppression
 - 10) Lighting
 - 11) Electrical Power
 - 12) Communications
 - 13) Electronic Safety and Security
 - b. Complete floor plans to a minimum of 1/4-inch equals 1-foot scale.
 - c. Mechanical rooms to a minimum of 1/2-inch equals 1-foot scale.
 - d. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
- H. Shop Drawings:
- 1. General:
 - a. Assemble complete submittal package for this Division into a single submittal.
 - 1) Partial submittals not accepted.
 - b. Prepare project-specific information, drawn accurately to scale.
 - c. Prepare new Shop Drawings by Contractor and not reproductions or tracings of Engineer's Design Drawings.
 - d. Submit shop drawings for review prior to beginning fabrication.

- 1) Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.
- e. Sheet Size: Match sheet size of Construction Drawings.
- f. Prepare in three-dimensional format utilizing the same digital data software program, version, and operating system utilized to develop the Construction Drawings.
- 2. Format:
 - a. Electronic: Submit electronic copies for Work of this Division in PDF format.
 - 1) Include a complete index in the original submittal.
 - (a) Incorporate links enabling navigation to each item.
 - (b) Identify with each item filed under a folder and labeled with its respective specification section number, Article and paragraph.
- 3. Include as a minimum:
 - a. Complete floor plans to a minimum of 1/4-inch equals 1-foot scale.
 - b. Mechanical, Electrical, and Technology rooms to a minimum of 1/2-inch equals 1-foot scale.
 - c. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
 - d. Fabricated equipment to a minimum of 1/4-inch equals 1-foot scale.
- I. Samples:
 - 1. Refer to individual Division sections for Submittal requirements.
- J. Certificates:
 - 1. Refer to individual Division sections for Submittal requirements.
- K. Delegated Design Submittals:
 - 1. Refer to individual Division sections for Submittal requirements.
 - 2. Fire protection system designs must bear the stamp and seal of the registered Professional Engineer who prepared the documents. The Engineer's stamp certifies that the work was done under the Engineer's supervision and control. Certification from NICET technicians, or other contractors, cannot replace the certification by the Engineer. Verify/coordinate with local building department for their specific requirements.
- L. Test and Evaluation Reports:
 - 1. Refer to individual Division sections for Submittal requirements.
- M. Manufacturers' Instructions:
 - 1. Refer to individual Division sections for Submittal requirements.
- N. Source Quality Control Submittals:
 - 1. Refer to individual Division sections for Submittal requirements.
- O. Site Quality Control Submittals:
 - 1. Refer to individual Division sections for Submittal requirements.
- P. Manufacturer Reports:
 - 1. Refer to individual Division sections for Submittal requirements.
- Q. Sustainable Design Submittals:
 - 1. Refer to individual Division sections for Submittal requirements.
- R. Qualification Statements:
 - 1. Refer to individual Division sections for Submittal requirements.

1.07 CLOSEOUT SUBMITTALS

- A. Maintenance Contracts:
 - 1. Refer to individual Division sections for Submittal requirements.
- B. Operations and Maintenance Data:
 - 1. General:
 - a. Assemble complete submittal package for this Division into a single submittal.

- 1) Partial submittals not accepted.
- b. Submit when the work is substantially complete.
- c. Submit manufacturer's operation and maintenance instruction manuals and parts lists for review on following equipment:
 - 1) Equipment scheduled on Drawings.
 - 2) Equipment requiring electrical connections or connections by other trades.
 - 3) As required by each specification section or by notes on the Drawings.
- 2. Format:
 - a. Electronic: Submit electronic copies for Work of this Division in PDF format.
 - 1) Include a complete index in the original submittal.
 - (a) Incorporate links enabling navigation to each item.
 - (b) Identify with each item filed under a folder and labeled with its respective specification section number, Article and paragraph.
- 3. Include for each item as a minimum:
 - a. Include name and contact information for location of source parts and service for each piece of equipment.
 - b. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified.
 - c. Manufacturer's operation and maintenance instruction manuals.
 - d. Manufacturer's detailed shop drawings including clearances required.
 - e. Manufacturer's detailed specifications.
 - f. Manufacturer's data sheets including capacities, operating speeds, power requirements, design and operating conditions, performance curves, characteristics scheduled or described on the Drawings, and similar data.
 - g. List the name of the motor manufacturer and service factor for each piece of equipment.
 - h. Indicate equipment operating weights including bases and weight distribution at support points.
 - i. Wiring diagrams showing factory installed wiring.
- C. Bonds:
 - 1. Refer to individual Division 00 and Division 01 sections for Submittal requirements.
- D. Warranty Documentation:
 - 1. Refer to individual Division 00 and Division 01 sections for Submittal requirements.
- E. Final Test and Evaluation Reports:
 - 1. Refer to individual Division sections for Submittal requirements.
- F. Record Documentation:
 - 1. Shop Drawings
 - a. Shop drawings updated with as-built information and submitted as the record drawing set.
 - 2. Record Drawings
 - a. General:
 - 1) Provide drawings with notations reflecting the as-built conditions.
 - 2) Notations to include any additions to or variations from the construction documents provided as part of the BIM coordination, RFIs, ASIs, Owner Changes, and Field Coordination.
 - 3) Prepare project-specific information, drawn accurately to scale.
 - 4) Provide project specific title block.
 - b. Sheet Size: Match sheet size of Construction Drawings.
 - c. Prepare in two-dimensional format utilizing the same digital data software program, version, and operating system utilized to develop the Construction Drawings.

- d. Format:
 - 1) Electronic: Submit electronic copies of record drawings for Work of this Division in PDF format.
 - (a) Include a complete index in the original submittal.
 - (b) Incorporate links enabling navigation to each item.
 - (c) Identify with each item filed under a folder and labeled with its respective specification section number, Article and paragraph.
- G. Demonstration and Training
 - 1. Training Plan:
 - a. Submit outline of instructional program for demonstration and training.
 - b. Include the following:
 - 1) List of training modules.
 - 2) Schedule of proposed dates, times, length of instruction time.
 - 3) Instructors' names for each training module.
 - 4) Learning objective and outline for each training module.
 - 2. Training Video Recordings:
 - a. Identification: On each copy, provide an applied label with the following information:
 - 1) Name of Project.
 - 2) Name and address of videographer.
 - 3) Name of Architect.
 - 4) Name of Contractor or Construction Manager.
- H. Sustainable Design Closeout Documentation:
 - 1. Refer to individual Division sections for Submittal requirements.
- I. Software:
 - 1. Refer to individual Division sections for Submittal requirements.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts:
 - 1. Refer to individual Division sections for Submittal requirements.
- B. Extra Stock Materials:
 - 1. Refer to individual Division sections for Submittal requirements.
- C. Tools:
 - 1. Refer to individual Division sections for Submittal requirements.

1.09 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Products and equipment are prohibited from containing pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
 - 2. General:
 - a. Conform work and materials to requirements of the local, State, and Federal authorities having jurisdiction and other applicable laws and regulations.
 - b. Where codes or standards are referenced, the applicable portions apply.
 - c. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, apply the more stringent.
 - d. Should any change in drawings or specifications be required to comply with governing regulations, notify the Architect prior to submitting bid.

- e. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, skillful and well-executed manner by competent workers. Provide a competent, experienced full-time Superintendent who is authorized to make decisions on behalf of the Contractor.
 - f. The Architect or Architect's Representative may conduct unannounced field reviews of any work completed or in progress during the Contractor's working hours. A report will be issued to the Contractor if the field review of the systems construction has revealed elements of the work which are inconsistent with the Contract Documents. All items in the report are to be addressed in writing by the Contractor within 2 weeks and corrections in the field made as directed.
- B. Apparatus:
- 1. Build and install to deliver full rated capacity at the efficiency for which it was designed.
 - 2. Provide entire system and apparatus that operate at full capacity without objectionable noise or vibration.
- C. For remodel projects, the existing system must remain fully operational, or provisions made to provide coverage while the new system is being installed. New installation switchover requires minimal down time. Provide method to maintain fire protection or fire watch during any system down time. Include any related cost for materials or labor that is needed for providing continuous coverage.
- D. Install equipment level and true. Provide housekeeping pads and curbs accounting for floor or roof slope.
- E. Materials and Equipment:
- 1. Provide new work of good quality, free of faults and defects and in conformance with the Construction documents.
 - 2. Each piece of equipment furnished will meet the detailed requirements of the Drawings and Specifications and will be suitable for the installation shown. Equipment not meeting the requirements will not be acceptable, even though specified by name along with other manufacturers.
 - 3. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
 - 4. Furnish materials and equipment of size, make, type, and quality herein specified.
 - 5. Equipment scheduled by performance or model number is considered as the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the Contractor is responsible for changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements, or any other differences which impact the project.
- F. Workmanship:
- 1. General: Install materials in a neat and professional manner.
 - 2. Manufacturer's Instructions:
 - a. Follow manufacturer's directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division Specifications, obtain clarification before starting work.
- G. Cutting and Patching:
- 1. Provide cutting, patching, and repairing for the proper installation and completion of the work specified in this Division by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work. This work includes but is not limited to plastering, masonry work, concrete work, carpentry work, and painting.

2. Make additional openings required in building construction by drilling or cutting. Use of jackhammer is specifically prohibited.
 3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
 4. Do not pierce beams, columns or structure members without approval from the Architect and structure engineer, and then only as directed.
 5. New or existing work cut or damaged will be restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces will be repaired, refinished, and left in condition existing prior to commencement of work.
- H. Visibly damaged goods are to be returned to the supplier and replaced at no additional cost to the Owner.
- I. Contractor Responsibility:
1. Examination of building and site responsibility:
 - a. Examine site and building prior to installation to determine conditions affecting the scope of work.
 - b. Contact Owner representative for arrangements.
 2. Respect and protect the privacy and confidentiality of Owner, its employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the State and Owner policies.
 3. Total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications.
 4. Specified systems installed under the direction of a qualified Contractor. Qualification requirements include submittal by the Contractor to the Architect of the following:
 - a. Have experience with three or more installations of systems comparable in size, complexity, type, and design as specified herein.
 - b. Perform each of these installations satisfactorily for at least one year after final acceptance by the user. Include the names, locations, and point of contact for these installations as a part of the initial submittal documentation.
 - c. List of previous projects of this scope, size, and nature, including names and sizes of projects, description of work, time of completion, and names of contact persons for reference.
- J. Manufacturers:
1. Equipment in these Sections are the standard products of a manufacturer regularly engaged in the manufacture of such products unless specified otherwise. Provide commercial grade components and products used in the system that comply with these Specifications.
 2. Each component of equipment identifies the manufacturer's name, model, and applicable serial number. The Owner's authorized representative retains the right to reject products that reflect, in their opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.
- K. Certifications:
1. Refer to individual Division sections for Submittal requirements.
- L. Sustainability Standards Certifications:
1. Refer to individual Division sections for Submittal requirements.
- M. Preconstruction Testing:
1. Refer to individual Division sections for Submittal requirements.
- N. Site Samples:
1. Refer to individual Division sections for Submittal requirements.
- O. Mock-ups:
1. Refer to individual Division sections for Submittal requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Assume custody and responsibility for the items upon delivery and determining that the contents are complete and in satisfactory condition for installation.
- B. The Contractor is responsible for handling and control of equipment and liable for material loss due to delivery and storage problems.
- C. Materials and equipment delivered and placed in storage will be stored with protection from the weather, humidity, and temperature variation, dirt, and dust or other contaminants.
- D. Coordinate deliveries and submittals with the General Contractor/Owner to ensure a timely scheduled installation.
- E. Equipment and materials are to be delivered to the site no more than three weeks prior to the commencement of its installation. Coordinate with General Contractor/Owner for the location of storage materials.

1.11 SITE CONDITIONS

- A. Existing Conditions:
 - 1. Prior to bidding, verify and become familiar with existing conditions by visiting the site.
 - 2. Include related costs associated with site factors in the initial bid proposal.
- B. Coordinate exact requirements governed by actual job conditions. Check information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.
- C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City, and Utility Company.

1.12 WARRANTY

- A. Provide a written guarantee covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.
- B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.
- C. Correct warranty items promptly upon notification.
- D. Apparatus:
 - 1. Free of defects of material and workmanship and in accord with the Contract Documents.
 - 2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.

1.13 DEMOLITION AND SALVAGE

- A. General:
 - 1. Where affected by work, remove or relocate equipment, services, and systems encountered during the course of the remodel/construction work to a safe location that will be undisrupted by further construction.
- B. Salvage and Disposal:
 - 1. Removed materials, not containing hazardous waste, not scheduled for reuse are the property of the Contractor for removal from the site, except for those items specifically indicated on the Drawings for salvage or reuse.
 - 2. Identify materials containing, or possibly containing, hazardous waste for removal and disposal by the Hazardous Waste Contractor.
 - 3. Neatly store salvaged items at one location at the site where directed by the Owner's Representative.

PART 2 PRODUCTS

2.01 MACHINERY GUARDS

- A. Furnish guards for protection on rotating and moving parts of equipment. Provide guards for drives and motor pulleys, regardless of being enclosed in a metal cabinet.

- B. Design guards to not restrict air flow or heat transfer.
- C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards easily removable for pulley adjustment or removal and changing of belts.
- D. Meet OSHA requirements including back plates.

2.02 ELECTRICAL EQUIPMENT

- A. General:
 - 1. Equipment and install work as specified under Division 26, Electrical.
- B. Motors:
 - 1. Furnish as integral part of driven equipment. Drip-proof induction type with ball bearings unless noted otherwise
 - 2. Built to NEMA Standards for the service intended.
 - 3. Rated for the voltage specified, suitable for operation within the range of 10 percent above to 10 percent below the specified voltage.
 - 4. Manufacturers
 - a. Baldor
 - b. Westinghouse
 - c. General Electric
 - d. Approved equal
 - 5. Where provided, refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.
 - 6. Refer to individual product sections for additional motor requirements.
 - 7. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors have quick trip devices.
- C. Starters:
 - 1. Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.
- D. Equipment Wiring:
 - 1. Provide interconnecting wiring within or on a piece of fire suppression equipment with the equipment unless shown otherwise. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.
- E. Control Wiring:
 - 1. Provide control wiring for fire suppression equipment.
- F. Codes:
 - 1. Electrical equipment and products to bear the UL as required by governing codes and ordinances.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fire protection systems to serve the entire building.
- B. The drawings indicate approximate locations of piping, sprinkler zones, and types of systems.
 - 1. The drawings do not indicate the locations of sprinkler heads in ceiling areas.
 - 2. Locate sprinklers in the center of ceiling panels and symmetrically within rooms and down corridors, coordinated with and in pattern with lights and grilles. Deviations must be approved

3.02 PAINTING

- A. General:

1. Coordinate painting of fire suppression equipment and items with products and methods in conformance with the appropriate Division of Work, Painting.
- B. Equipment Rooms and Finished Areas:
 1. Hangers: One coat of black enamel.
 2. Miscellaneous Iron Work: One coat of black enamel.
 3. Structural Steel Stands: One coat of black enamel.
 4. Tanks: One coat of black enamel.
 5. Equipment Bases: One coat of black enamel.
 6. Steel Valve Bodies and Bonnets: One coat of black enamel.
 7. Equipment: One coat of red machinery enamel. Do not paint nameplates.
 8. Sprinkler Heads: Not painted.
- C. Concealed Spaces (above ceilings, not visible):
 1. Hangers, miscellaneous iron work, valve bodies, and bonnets: Not painted.
- D. Sprinkler Piping:
 1. Concealed from view: Not painted.
 2. Exposed to view: Paint pipe and hangers exposed to view, including in equipment spaces, with one coat approved rust inhibiting primer. Final finish coat as specified in conformance with the appropriate Division of Work, Painting.
 3. Exterior: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel. Final finish coat as specified in conformance with the appropriate Division of Work, Painting.
 4. Alarm Bell: Factory paint with two coats of red enamel.

3.03 CLEANING

- A. General:
 1. Clean equipment and piping of stampings and markings (except those required by codes), iron cuttings, and other refuse.
 2. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.
 3. Use particular care in lubricating bearings to avoid by over-lubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.
- B. Painted Surfaces:
 1. Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.
- C. Additional requirements are specified under specific Sections of this Division.

3.04 ELECTRICAL EQUIPMENT

- A. Do not install fire suppression systems in switchgear rooms, transformer vaults, telephone rooms, or electric closets except as indicated.
- B. Fire Suppression systems not to pass over switchboards or electrical panelboards. Where conflict exists, bring to attention of Architect.

3.05 PROTECTION

- A. Keep pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter.
- B. Protect piping, conduit, equipment, and apparatus against dirty water, chemical, or mechanical damage both before and after installation.

- C. Restore damaged or contaminated equipment, or apparatus to original conditions or replace at no cost to the Owner.
- D. Protect bright finished shafts, bearing housings, and similar items until in service. No rust permitted.
- E. Cover otherwise suitably protected equipment and materials stored on the job site.

END OF SECTION 21 0500

SECTION 21 0548
VIBRATION AND SEISMIC CONTROLS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Seismic control requirements.
- C. Vibration-isolated equipment support bases.
- D. Vibration isolators.
- E. External seismic snubber assemblies.
- F. Seismic restraint systems

1.02 RELATED REQUIREMENTS

1.03 DEFINITIONS

- A. Fire Suppression Component: Where referenced in this section in regards to seismic controls, applies to any portion of the fire suppression system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., piping).
- B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.04 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- B. ASCE 19 - Structural Applications of Steel Cables for Buildings.
- C. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications.
- D. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment.
- E. FEMA 413 - Installing Seismic Restraints for Electrical Equipment.
- F. FEMA 414 - Installing Seismic Restraints for Duct and Pipe.
- G. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage.
- H. ICC-ES AC156 - Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components.
- I. NFPA 13 - Standard for the Installation of Sprinkler Systems.
- J. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Seismic Controls:
 - a. Coordinate the arrangement of seismic restraints with piping, conduit, equipment, and other potential conflicts installed under other sections or by others.
 - b. Coordinate the work with other trades to accommodate relative positioning of essential and nonessential components in consideration of seismic interaction.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.06 SUBMITTALS

- A. See Section 21 0500 - Common Work Results for Fire Suppression for submittal procedures.
- B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
 2. Seismic Controls: Include seismic load capacities.
- D. Shop Drawings - Vibration Isolation Systems:
 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.
 2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.
- E. Shop Drawings - Seismic Controls:
 1. Include dimensioned plan views and sections indicating proposed fire suppression component locations and distributed system routing, with locations and details of gravity supports and seismic restraints and associated attachments.
 2. Identify mounting conditions required for equipment seismic qualification.
 3. Identify anchor manufacturer, type, minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 4. Indicate proposed arrangement of distributed system trapeze support groupings.
 5. Indicate proposed locations for distributed system flexible fittings and/or connections.
 6. Indicate locations of seismic separations where applicable.
 7. Include point load drawings indicating design loads transmitted to structure at each attachment location.
- F. Seismic Design Data:
 1. Compile information on project-specific characteristics of actual installed fire suppression components necessary for determining seismic design forces required to design appropriate seismic controls.
 2. Include structural calculations, stamped or sealed by seismic controls designer, demonstrating suitability of seismic controls for seismic design forces.
- G. Certification for seismically qualified equipment; identify basis for certification.
- H. Evaluation Reports: For products specified as requiring evaluation and recognition by a qualified evaluation service, provide current evaluation reports.
- I. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- J. Manufacturer's detailed field testing and inspection procedures.
- K. Field quality control test reports.

1.07 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

- C. Seismic Controls Designer Qualifications: Registered professional engineer licensed in the State in which the Project is located and with minimum five years experience designing seismic restraints for nonstructural components.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

- A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing fire suppression equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
 - 3. Select seismic type vibration isolators to comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
 - 4. Select vibration isolators for outdoor equipment to comply with wind design requirements.
 - 5. Select vibration-isolated equipment support bases and associated vibration isolators to provide minimum 2-inch operating clearance beneath base unless otherwise indicated.
- D. Equipment Isolation:
 - 1. Equipment Type: Pumps.
 - a. Mounting: Vibration-isolated concrete inertia base.
 - b. Isolator Type (Seismic Application): Seismic type resilient material isolator mounts.
- E. Piping Isolation:
 - 1. Use flexible piping connections to vibration-isolated equipment.

2.02 SEISMIC CONTROL REQUIREMENTS

- A. Provide fire suppression component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor fire suppression components.
- B. Seismic Design Criteria: Obtain from project Structural Engineer of Record.
- C. Component Importance Factor (Ip): Fire suppression components to be assigned a component importance factor (Ip) of 1.5 unless otherwise indicated.
- D. Seismic Qualification of Equipment:
 - 1. Provide special certification for fire suppression equipment furnished under other sections and assigned a component importance factor (Ip) of 1.5, certifying that equipment will remain operable following a design level earthquake.
 - 2. Seismic qualification to be by shake table testing in accordance with recognized testing standard procedure, such as ICC-ES AC156, acceptable to authorities having jurisdiction.
 - 3. Notify Architect and obtain direction where mounting restrictions required by conditions of seismic certification conflict with specified requirements.
 - 4. Seismically qualified equipment to be furnished with factory-installed labels referencing certificate of compliance and associated mounting restrictions.

- E. Premanufactured Modular Fire Suppression Equipment: Where not otherwise seismically qualified, premanufactured modules 6 feet high and taller furnished under other sections to be designed in accordance with seismic provisions for nonbuilding structures.
- F. Seismic Restraints:
1. Provide seismic restraints for fire suppression components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.
 2. Seismic Restraint Exemptions, All Seismic Design Categories:
 - a. Fire Suppression Piping Exemptions, All Seismic Design Categories:
 - 1) Lateral sway bracing for piping individually supported within 6 inches of the structure measured between the top of pipe and the point of attachment to the structure, where all conditions for exception specified in NFPA 13 are met.
 - 2) Lateral sway bracing for branch lines smaller than 2-1/2 inches in diameter, where branch line restraint is provided in accordance with NFPA 13.
 3. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:
 - a. ASHRAE (HVACA).
 - b. FEMA 412.
 - c. FEMA 413.
 - d. FEMA 414.
 - e. FEMA E-74.
 - f. SMACNA (SRM).
 4. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.
 5. Seismic Type Vibration Isolators:
 - a. Comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
 6. External Seismic Snubber Assemblies:
 - a. Provide quantity and arrangement of external seismic snubber assemblies as required to restrain equipment in all directions (both lateral and vertical).
 - b. Do not use external seismic snubber assemblies that restrain equipment only in one or more lateral directions (but not vertical) except where uplift forces are zero or are addressed by other restraints.
 7. Seismic Restraint Systems:
 - a. Arrange restraint elements to avoid obstruction of sprinklers in accordance with NFPA 13.
 - b. Except where otherwise restricted, use of either cable or rigid restraints is permitted.
 - c. Use only cable restraints to restrain vibration-isolated fire suppression components.
 - d. Use only one restraint system type for a given fire suppression component or distributed system (e.g., piping) run; mixing of cable and rigid restraints on a given component/run is not permitted.
 - e. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain fire suppression component in all lateral directions; consider bracket geometry in anchor load calculations.
 - f. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid restraints loaded in tension, in excess of downward tensile load due to supported fire suppression component weight.

- g. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported fire suppression component weight.
 - h. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.
 - i. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.
 - j. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.
- G. Seismic Attachments:
- 1. Comply with support and attachment requirements of NFPA 13.
 - 2. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.
 - 3. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.
 - 4. Do not use power-actuated fasteners except where permitted by applicable code.
 - 5. Do not use friction clips (devices that rely on mechanically applied friction to resist loads) except where permitted by applicable code. Beam clamps may be used for supporting sustained loads where provided with restraining straps, but not for sway bracing attachments as prohibited by NFPA 13.
 - 6. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 - 7. Concrete Housekeeping Pads:
 - a. Increase size of pad as required to comply with anchor requirements.
 - b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.
- H. Seismic Interactions:
- 1. Include provisions to prevent seismic impact between fire suppression components and other structural or nonstructural components.
 - 2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.
 - 3. Comply with minimum clearance requirements between other equipment, distribution systems, and associated supports and fire protection sprinkler system drops and springs.
- I. Seismic Relative Displacement Provisions:
- 1. Use suitable fittings or flexible connections, in accordance with NFPA 13, to accommodate:
 - a. Relative displacements at connections between components, including distributed systems (e.g., piping); do not exceed load limits for equipment utility connections.
 - b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.
 - c. Design displacements at seismic separations.
 - d. Anticipated drifts between floors.
 - 2. Provide clearance around fire suppression system piping extending through walls, floors, platforms, and foundations in accordance with NFPA 13.

2.03 MANUFACTURERS

- A. AFCON.
- B. PHD Manufacturing, Inc.

- C. TOLCO, a product of Eaton Corporation.
- D. Mason Industries, Inc.

2.04 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

- A. Manufacturers:
 - 1. Vibration-Isolated Equipment Support Bases:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries.
 - 2. Source Limitations: Furnish vibration-isolated equipment support bases and associated components and accessories produced by a single manufacturer and obtained from a single supplier.
- B. Vibration-Isolated Concrete Inertia Bases:
 - 1. Description: Concrete-filled engineered steel forms with integral mounting provisions for vibration isolators, sized and configured for mounting of equipment.
 - 2. Minimum Base Depth: 6 inches.
 - 3. Minimum Base Mass (Including Concrete): 1.5 times weight of supported equipment.
 - 4. Concrete Reinforcement: Welded or tied reinforcing bars running both ways in a single layer.
 - 5. Concrete: Filled on site with minimum 3000 psi concrete.
 - 6. Pump Applications: Size and configure bases for piping elbow supports as required.

2.05 VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Vibration Isolators:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries.
 - 2. Source Limitations: Furnish vibration-isolators and associated accessories produced by a single manufacturer and obtained from a single supplier.
- B. General Requirements:
 - 1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
 - 2. Spring Elements for Spring Isolators:
 - a. Color code or otherwise identify springs to indicate load capacity.
 - b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
 - c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
 - d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
 - e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
 - f. Selected to function without undue stress or overloading.
 - 3. Seismic Snubbing Elements for Seismic Isolators:
 - a. Air Gap: Between 0.125 inches and 0.25 inches unless otherwise indicated.
 - b. Points of Contact: Cushioned with resilient material, minimum 0.25 inch thick; capable of being visually inspected for damage and replaced.
- C. Vibration Isolators for Seismic Applications:
 - 1. Type _____ - Restrained Spring Isolators, Seismic:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) in series with elastomeric (e.g., neoprene, rubber) isolator material within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop; specifically designed and rated for seismic applications with integral snubbing in all directions.

- b. Bottom Load Plate: Steel with provisions for bolting to supporting structure as required.
- c. Furnished with integral leveling device for positioning and securing supported equipment.
- d. Provides constant free and operating height.
- 2. Type _____ - Spring Isolator Hangers, Seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection; specifically designed and rated for seismic applications with vertical limit stop to prevent upward travel of hanger rod and cushion impact.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.

2.06 EXTERNAL SEISMIC SNUBBER ASSEMBLIES

- A. Manufacturers:
 - 1. External Seismic Snubber Assemblies:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries.
 - 2. Source Limitations: Furnish external seismic snubber assemblies and associated accessories produced by a single manufacturer and obtained from a single supplier.
- B. Description: Steel snubbing assemblies designed for external attachment to both equipment and supporting structure that, as part of a complete system, restrain equipment motion in all directions during a seismic event while maintaining vibration isolation during normal operation.
- C. Seismic Snubbing Elements:
 - 1. Air Gap: Between 0.125 inches and 0.25 inches unless otherwise indicated.
 - 2. Points of Contact: Cushioned with resilient material, minimum 0.25 inch thick; capable of being visually inspected for damage and replaced.

2.07 SEISMIC RESTRAINT SYSTEMS

- A. Manufacturers:
 - 1. Seismic Restraint Systems:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries.
 - 2. Source Limitations: Furnish seismic restraint system components and accessories produced by a single manufacturer and obtained from a single supplier.
- B. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.
- C. Where required by NFPA 13, provide products listed as complying with UL 203A.
- D. Cable Restraints:
 - 1. Comply with ASCE 19.
 - 2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.
 - 3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.
 - 4. Use protective thimbles for cable loops.
- E. Rigid Restraints: Use MFMA-4 steel channel (strut) for structural element; suitable for both compressive and tensile design loads.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.

- B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 CODE-REQUIRED SPECIAL INSPECTIONS

- A. Arrange work to accommodate tests and/or inspections performed by Special Inspection Agency employed by Owner or Architect in accordance with Division 01 and statement of special inspections as required by applicable building code.
- B. Frequency of Special Inspections: Where special inspections are designated as continuous or periodic, arrange work accordingly.
 - 1. Continuous Special Inspections: Special Inspection Agency to be present in the area where the work is being performed and observe the work at all times the work is in progress.
 - 2. Periodic Special Inspections: Special Inspection Agency to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.
- C. Seismic special inspections include, but are not limited to:
 - 1. Seismically Qualified Equipment: Verification that label, anchorage, and mounting comply with certificate of compliance.
 - 2. Installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units for Seismic Design Categories C, D, E, and F; periodic inspection.
 - 3. Installation and anchorage of vibration isolation systems for Seismic Design Categories C, D, E, and F where the approved Contract Documents require a nominal clearance of 1/4 inch or less between equipment support frame and seismic restraint; periodic inspection.
 - 4. Verification of required clearances between other equipment, distribution systems, and associated supports and fire protection sprinkler system drops and sprigs for Seismic Design Categories C, D, E, and F; periodic inspection.
- D. Prior to starting work, Contractor to submit written statement of responsibility to authorities having jurisdiction and to Owner acknowledging awareness of special requirements contained in the statement of special inspections.
- E. Special Inspection Agency services do not relieve Contractor from performing inspections and testing specified elsewhere.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Secure fasteners according to manufacturer's recommended torque settings.
- D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- E. Vibration Isolation Systems:
 - 1. Vibration-Isolated Equipment Support Bases:
 - a. Provide specified minimum clearance beneath base.
 - 2. Spring Isolators:
 - a. Position equipment at operating height; provide temporary blocking as required.
 - b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.
 - c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.
 - 3. Isolator Hangers:

- a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.
 - b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.
 - 4. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
 - 5. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
 - 6. Adjust isolators to be free of isolation short circuits during normal operation.
 - 7. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.
- F. Seismic Controls:
- 1. Provide specified snubbing element air gap; remove any factory-installed spacers, debris, or other obstructions.
 - 2. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.
 - 3. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch, use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch or less.
 - 4. Equipment with Sheet Metal Housings:
 - a. Use Belleville washers to distribute stress over a larger surface area of the sheet metal connection interface as approved by manufacturer.
 - b. Attach additional steel as approved by manufacturer where required to transfer loads to structure.
 - c. Where mounting surface is irregular, do not shim housing; reinforce housing with additional steel as approved by manufacturer.
 - 5. Concrete Housekeeping Pads:
 - a. Size in accordance with seismic design to meet anchor requirements.
 - b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.
 - 6. Seismic Restraint Systems:
 - a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.
 - b. Install restraints within permissible angles in accordance with seismic design.
 - c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.
 - d. Install cable restraints for vibration-isolated components slightly slack to prevent short-circuiting of isolation.
 - e. Install hanger rod stiffeners where indicated using only specified clamps; do not weld stiffeners to hanger rod.

3.04 FIELD QUALITY CONTROL

- A. See Division 01, for additional requirements.
- B. Inspect vibration isolation and/or seismic control components for damage and defects.
- C. Provide manufacturer representative or authorized technician services to assist with inspection and testing of vibration isolation systems and seismic controls. Submit a detailed copy of manufacturer recommended inspection, testing, and field report procedures.
- D. Vibration Isolation Systems:
 - 1. Verify isolator static deflections.
 - 2. Verify required clearance beneath vibration-isolated equipment support bases.

3. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.
- E. Seismic Controls:
 1. Verify snubbing element air gaps.
- F. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.
- G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.05 ATTACHMENTS

- A. Statement of special inspections.

END OF SECTION 21 0548

**SECTION 21 1300
FIRE-SUPPRESSION SPRINKLER SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wet-pipe sprinkler system.
- B. System design, installation, and certification.
- C. Fire department connections.

1.02 RELATED REQUIREMENTS

- A. Section 21 0500 - Common Work Results for Fire Suppression.
- B. Section 21 0548 - Vibration and Seismic Controls for Fire Suppression Piping and Equipment.
- C. Section 21 0553 - Identification for Fire Suppression Piping and Equipment.
- D. Section 21 3000 - Fire Pumps.
- E. Section 26 0583 - Wiring Connections.
- F. Section 28 4600 - Fire Detection and Alarm.

1.03 REFERENCE STANDARDS

- A. FM (AG) - FM Approval Guide.
- B. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
- C. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
- D. NFPA 13 - Standard for the Installation of Sprinkler Systems.
- E. NFPA 1963 - Standard for Fire Hose Connections.
- F. UL (DIR) - Online Certifications Directory.
- G. UL 405 - Standard for Safety Fire Department Connection Devices.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.

1.05 SUBMITTALS

- A. See Section 21 0500 - Common Work Results for Fire Suppression for submittal procedures.
- B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Shop Drawings:
 - 1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
 - 2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
 - 3. Submit shop drawings, product data, and hydraulic calculations to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.
- D. Samples: Submit two of each style of sprinkler specified.
- E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
- F. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 01 for additional requirements.

2. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
 3. Sprinkler Wrenches: For each sprinkler type.
- H. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.06 QUALITY ASSURANCE

- A. Maintain one copy of referenced design and installation standard on site.
- B. Conform to FM (AG) and UL (DIR) requirements.
- C. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in Owner.
- D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years experience.
- E. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience and approved by manufacturer.
- F. Equipment and Components: Provide products that bear FM (AG) and UL (DIR) label or marking.
- G. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sprinklers, Valves, and Equipment:
 1. Tyco Fire Protection Products.
 2. Viking Corporation.
 3. Victaulic.
 4. Reliable Automatic Sprinklers.

2.02 SPRINKLER SYSTEM

- A. Sprinkler System: Provide coverage for entire building unless otherwise noted.
- B. Occupancy: Ordinary hazard, Group 1; comply with NFPA 13.
- C. Water Supply: Determine volume and pressure from water flow test data.
 1. Revise design when test data available prior to submittals.
- D. Interface system with building fire and smoke alarm system.
- E. Provide fire department connections where indicated.
- F. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.
- G. Pipe Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 6. Other Types: As required.

2.03 SPRINKLERS

- A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
 1. Response Type: Quick.

2. Coverage Type: Standard.
 3. Finish: Brass.
 4. Escutcheon Plate Finish: Antique Brass.
 5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- B. Exposed Area Type: Pendant type with guard.
1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Finish: Brass.
 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- C. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Finish: Brass.
 4. Escutcheon Plate Finish: Brass.
 5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- D. Dry Sprinklers: Concealed pendant type with matching push on escutcheon plate.
1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Finish: Brass.
 4. Cover Plate Finish: Brass.
 5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- E. Residential Sprinklers: Concealed upright type with matching push on escutcheon plate.
1. Response Type: Quick.
 2. Finish: Brass.
 3. Cover Plate Finish: Antique Brass.
 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- F. Storage Sprinklers: Pendant type with guard.
1. Response Type: Standard.
 2. Coverage Type: Standard.
 3. Finish: Chrome plated.
 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- G. Guards: Finish to match sprinkler finish.
- H. Spray Nozzles: Brass with solid cone discharge, 30 degrees of arc with blow-off dust cap.
1. Finish: Brass.
- I. Flexible Drop System: Stainless steel, multiple use, open gate type.
1. Application: Use to properly locate sprinkler heads.
 2. Include all supports and bracing.
 3. Provide braided type tube as required for the application.

2.04 PIPING SPECIALTIES

- A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
1. Activate electric alarm.
 2. Test and drain valve.
 3. Replaceable internal components without removing valve from installed position.
- B. Backflow Preventer: Double check valve assembly backflow preventer with drain and OS & Y gate valve on each end.
- C. Test Connections:

1. Backflow Preventer Test Connection:
 - a. Provide downstream of the backflow prevention assembly, listed hose valves with 2.5 inch National Standard male hose threads with cap and chain.
 - b. Furnish one valve for each 250 gpm of system demand or fraction thereof.
 - c. Provide permanent sign reading "Test Valve" in accordance with Section 21 0553.
- D. Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy chrome plated gong and motor housing, nylon bearings, and inlet strainer.
- E. Electric Alarm: Electrically operated chrome plated gong with pressure alarm switch.
- F. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.
- G. Fire Department Connections:
 1. Type: Free standing made of corrosion resistant metal complying with UL 405.
 - a. Inlets: Two way, 2-1/2 inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.
 - b. Outlet: Bottom with pipe threads, 4 NPS.
 - c. Rated Working Pressure: 175 psi.
 - d. Finish: Chrome.
 - e. Sleeve: Brass, 18 inches height.
 - f. Signage: Raised or engraved lettering 1 inch minimum indicating system type.
 - g. Manufacturers:
 - 1) Elkhart Brass Manufacturing Company, Inc.
 - 2) Fire End & Croker Corporation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with referenced NFPA design and installation standard.
- B. Install equipment in accordance with manufacturer's instructions.
- C. Install buried shut-off valves in valve box. Provide post indicator.
- D. Provide approved backflow preventer assembly at sprinkler system water source connection.
- E. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.
- F. Locate outside alarm gong on building wall as indicated.
- G. Place pipe runs to minimize obstruction to other work.
- H. Place piping in concealed spaces above finished ceilings.
- I. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.
- J. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- K. Install and connect to fire pump system in accordance with Section 21 3000.
- L. Install air compressor on vibration isolators. Refer to Section 21 0548.
- M. Flush entire piping system of foreign matter.
- N. Install guards on sprinklers where indicated.
- O. Hydrostatically test entire system.
- P. Require test be witnessed by Fire Marshal.

3.02 INTERFACE WITH OTHER PRODUCTS

- A. Ensure required devices are installed and connected as required to fire alarm system.

END OF SECTION 21 1300

**SECTION 22 0500
COMMON WORK RESULTS FOR PLUMBING**

PART 1 GENERAL

1.01 SUMMARY

- A. The intent of Division 22, Plumbing and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include all work specified in Division 22, Plumbing and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.
- B. Division 22, Plumbing and the accompanying Drawings are complementary and as binding as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa. Specifications supersede drawings in case of conflict.
- C. The Drawings that accompany the Division 22, Plumbing, are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in fixture location prior to roughing-in, without cost impact.
- D. The General and Supplemental Conditions apply to this Division, including but not limited to:
 - 1. Drawings and specifications.
 - 2. Public ordinances, permits.
 - 3. Include payments and fees required by governing authorities for work of this Division.

1.02 RELATED SECTION

- A. Division 01, General Requirements
- B. Division 22, Plumbing

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Products and equipment prohibited from containing pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
 - 2. General:
 - a. Conform work and materials to local and State codes, and Federal, State and other applicable laws and regulations.
 - 3. Responsible for obtaining and payment for permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.
- B. New materials and equipment. Work of good quality, free of faults and defects and in conformance with the Contract Documents.
- C. Build and install apparatus to deliver its full rated capacity at the efficiency for which it was designed.
- D. Operate the entire plumbing system and apparatus at full capacity without objectionable noise or vibration.
- E. Install equipment level and true. Use housekeeping pads and curbs to account for floor or roof slope.
- F. Materials and Equipment:

1. Meet detailed requirements of the Drawings and Specifications and suitable for the installation shown. Equipment not meeting requirements will not be acceptable, even though specified by name along with other manufacturers.
 2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
 3. Furnish materials and equipment of size, make, type, and quality herein specified.
 4. Equipment scheduled by performance or model number considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements or any other differences which impact the project.
- G. Workmanship:
1. General:
 - a. Install materials in a neat and professional manner.
 2. Manufacturer's Instructions:
 - a. Follow manufacturer's directions where they cover points not specifically indicated.
 - b. If in conflict with the Drawings and Division 22, Plumbing, obtain clarification before starting work.
- H. Cutting and Patching:
1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
 2. Additional openings required in building construction made by drilling or cutting. Use of jackhammer is specifically prohibited.
 3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
 4. Do not pierce beams or columns without permission of Architect and then only as directed.
 5. Restore new or existing work cut or damaged to its original condition.

1.04 SUBMITTALS

- A. Shop Drawings:
1. Contract Drawings indicate the general layout of the piping, and various items of equipment.
 2. Coordinate with other trades and field conditions.
 3. Prepare Shop Drawings of piping, and equipment installations.
 4. Prepare new Shop Drawings by Contractor and not reproductions or tracings of Architect's Drawings.
 5. Overlay drawings with shop drawings of other trades and check for conflicts.
 6. Drawings same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings.
 7. Fully dimensioned including both plan and elevation dimensions.
 8. Shop drawings cannot be used to make scope changes.
 9. Prepare in two-dimensional format.
 10. Shop drawings include but are not limited to:
 - a. Plumbing site plan drawn to same scale as site plan.
 - b. Complete floor plans with plumbing to a minimum of 1/8-inch equals 1-foot scale.

11. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.
- B. Product Data:
1. Submit product data for review on scheduled pieces of equipment, on equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications and data sheets. Data includes the following:
 - a. Capacities
 - b. RPM
 - c. BHP
 - d. Pressure Drop
 - e. Design and Operating Pressures
 - f. Temperatures
 2. Manufacturer's abbreviations or codes are not acceptable.
 3. List the name of the motor manufacturer and service factor for each piece of equipment.
 4. Indicate equipment operating weights including bases and weight distribution at support points.
 5. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.
- C. Submission Requirements:
1. Shop Drawings and Product Data:
 - a. Refer to Division 01, General Requirements for additional requirements related to submittals.
 - b. Submit electronic copies of shop drawings and product data for Work of Division 22, Plumbing in PDF format with each item filed under a folder and labeled with its respective specification section number, article, and paragraph and mark, if applicable.
 - c. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.
 - d. The bulk of the shop drawings and product data, excepting Controls and Instrumentation, included with the original submittal. Controls and Instrumentation submittals may lag but still complete when submitted. Partial submittals will not be accepted. Other stragglers submitted after return of the original binder includes a tab similar to that originally submitted. Upon receipt of the returned late submittal, insert them in the previously submitted binder.
- D. Contractor Responsibilities:
1. Submit submittals at one time and are in proper order.
 2. Ensure equipment will fit in the space provided.
 3. Assure that deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.05 AS-BUILT DRAWINGS

- A. Provide 3D model and record drawings at the end of the project on CD-ROM.
- B. 3D model in the following format:
 1. AutoCAD
- C. Provide record drawings in hard copy and pdf format. Drawings include the following:
 1. Project specific titleblock.

2. Notations reflecting the as built conditions of any additions to or variations from the construction documents provided as part of the BIM coordination, RFIs, ASIs, Owner Changes, and Field Coordination.

1.06 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNER'S INSTRUCTIONS

- A. Refer to Division 01, General Requirements for additional requirements.
- B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Show literature on 8-1/2-inches by 11-inches sheets or catalogs suitable for side binding.
- C. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment.
- D. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for electrically powered equipment.
- E. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions cover all phases of control.
- F. Furnish competent engineer knowledgeable in this building system for minimum of five 8-hour days to instruct Owner in operation and maintenance of systems and equipment. Keep a log of this instruction including dates, times, subjects, and those present and present such log when requested by Architect.

1.07 PROJECT CONDITIONS

- A. Existing Conditions:
 1. Prior to bidding, verify and become familiar with existing conditions by visiting the site, and include factors which may affect the execution of this Work.
 2. Include related costs in the initial bid proposal.
- B. Coordinate exact requirements governed by actual job conditions. Check information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.
- C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City, and Utility Company.

1.08 WARRANTY

- A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.
- B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.
- C. Correct warranty items promptly upon notification.

1.09 PROVISIONS FOR LARGE EQUIPMENT

- A. Make provisions for the necessary openings in building to allow for admittance of equipment.

1.10 TEST REPORTS AND CERTIFICATES

- A. Submit one copy of test reports and certificates specified herein to the Architect.

1.11 SUBSTITUTIONS

- A. Submit requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 PRODUCTS

2.01 ACCESS PANELS

- A. Furnish under this Division as specified in another Division of work.

2.02 PIPE SLEEVES

- A. Interior Wall and Floor Sleeves: 18-gauge galvanized steel, or another pre-approved system.
- B. Interior Wall and Floor Sleeves, Fire Rated: Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.
- C. Exterior Wall Sleeves: Cast iron.
- D. On Grade Floor Sleeves: Same as exterior wall sleeves.
- E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.03 FLOOR, WALL AND CEILING PLATES

- A. Furnish stamped split type plates as follows:
 - 1. Floor Plates: Cast brass, chromium plated
 - 2. Wall and Ceiling Plates: Spun aluminum

PART 3 EXECUTION

3.01 ACCESS PANELS

- A. Install in accord with manufacturer's recommendations, coordinated with architectural features.
- B. Provide 2-hour fire rated doors where required bearing the UL label.
- C. Furnish 18-inch by 18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12-inch by 12-inch for walls unless indicated otherwise.
- D. Furnish where indicated and where required to access valves, trap primers, shock arresters, and other appurtenances requiring operation, service, or maintenance. Submit proposed locations for review prior to installation.

3.02 SLEEVES

- A. Interior Floor and Wall Sleeves:
 - 1. Provide sleeves large enough to provide 3/4-inch clearances around pipe.
 - 2. Where pipe is insulated, provide sleeves large enough to provide 3/4-inch clearance around insulation. Maintain continuous insulation as it passes through sleeve.
 - 3. Penetrations through mechanical room and fan room floors made watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.
- B. Sleeves Through Rated Floors and Walls:
 - 1. Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter
 - 2. Rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.
- C. Exterior Wall Sleeves Below Grade:
 - 1. Provide water tight sleeves. Install at pipes entering building below grade and where shown. Adjust to provide positive hydrostatic seal.
 - 2. Responsible for following manufacturer's procedure for installing and tightening seal. Secure sleeves against displacement.
- D. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.
- E. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.

- F. Layout work prior to concrete forming. Do cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.
- G. Floor sleeves maintain a water barrier by providing a water tight seal or they extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves extend 2-inches above finished floor level. Sleeves through roof extend 8-inches above roof. Wall sleeves flush with face of wall unless otherwise indicated. Waste stacks using carriers have sleeves flush with floor and sealed. Sleeves through planters extend 8-inches above planter base.
- H. Do not support pipes by resting pipe clamps on floor sleeves. Provide supplementary members so pipes are floor supported.
- I. Special sleeves detailed on drawings take precedence over this Section.

3.03 CLEANING

- A. General: Clean plumbing equipment, fixtures and piping of stampings and markings (except those required by codes), iron cuttings, and other refuse.
- B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.
- C. Additional requirements are specified under specific Sections of this Division.

3.04 EQUIPMENT PROTECTION

- A. Keep pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, fixtures, equipment, and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.
- B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.
- C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.05 ACCESSIBILITY

- A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.
- B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms, and walkways.

3.06 FLOOR, WALL AND CEILING PLATES

- A. Install on piping passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates completely cover opening around pipe.
- B. Secure wall and ceiling plates to pipe, insulation, or structure.
- C. Plates not to penetrate insulation vapor barriers.
- D. Plates not required in mechanical rooms or unfinished spaces.

3.07 PAINTING

- A. General:
 1. Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting.
 2. Exposed work under this division receives either a factory painted finish or a field prime coat finish, except:
 3. Exposed copper piping.
 4. Aluminum jacketed outdoor insulated piping.
- B. Equipment Rooms and Finished Areas:

1. Insulation: Not painted.
 2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
 3. Steel Valve Bodies and Bonnets: One coat of black enamel.
 4. Brass Valve Bodies: Not painted.
 5. Equipment:
 - a. One coat of grey machinery enamel.
 - b. Do not paint nameplates.
- C. Concealed Spaces (above ceilings, not visible):
1. Insulation: Not painted.
 2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Valve Bodies and Bonnets: Not painted.

3.08 ADJUSTING AND CLEANING

- A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations made accordingly and that recommended lubricants have been used.
- B. Use particular care in lubricating bearings to avoid damage by overlubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.09 ELECTRICAL EQUIPMENT

- A. Do not install piping for plumbing systems not serving electrical space in switchgear room, transformer vault, telephone room, or electric closet except as indicated.
- B. Piping for plumbing systems not to pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.10 EQUIPMENT CONNECTIONS

- A. Make final connections to equipment specified in sections other than Division 22, Plumbing of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.
- B. Piping:
 1. Connections include hot and cold water, sanitary waste and vent.
 2. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
 3. Independently support piping connections to prevent undue strain on equipment.

END OF SECTION 22 0500

**SECTION 22 0523
GENERAL DUTY VALVES AND SPECIALTIES FOR PLUMBING**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Check Valves
 - 2. Ball Valves
 - 3. Balancing Valves
 - 4. Water Relief Valves

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 22, Plumbing

1.03 SUBMITTALS

- A. Submit product data.

1.04 DEFINITIONS

- A. Cold working pressure
- B. Ethylene propylene copolymer rubber
- C. Acrylonitrile-butadiene, Buna-N, or nitrile rubber
- D. Nonrising stem
- E. Outside screw and yoke
- F. Rising stem
- G. Polytetrafluoroethylene plastic
- H. Steam working pressure
 - 1. Section 1417 of the Safe Drinking Water Act (SDWA) establishes the definition for lead free as a weighted average of 0.25 percent lead calculated across the wetted surfaces of a pipe, pipe fitting, plumbing fitting, and fixture and 0.2 percent lead for solder and flux. The Act provides a methodology for calculating the weighted average of wetted surfaces.

1.05 QUALITY ASSURANCE

- A. ASME Compliance:
 - 1. ASME B16.10 for ferrous valve dimensions.
 - 2. ASME B31.9 for building services piping valves.
 - a. NSF/ANSI 61 and/or NSF/ANSI 372 for valve materials for potable-water service.
ANSI/NSF-359

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. General: Where only NIBCO figure numbers are listed, equivalent products by those specified below are acceptable.
 - 1. Valves:
 - a. Balancing:
 - 1) Bell and Gossett
 - 2) Armstrong
 - 3) Tour and Anderson
 - 4) NIBCO
 - b. Ball:
 - 1) Gruvlok

- 2) Apollo
 - 3) Crane
 - 4) Hammond
 - 5) Milwaukee
 - 6) Victaulic
- B. Other Manufacturers: Submit substitution request.
- C. Use only one manufacturer.
- D. Valve ends may be threaded, flanged, soldered, or grooved, as applicable to piping system.
Refer to Section 22 21 13, Pipe and Pipe Fittings Plumbing for allowable fittings.

2.02 BALL VALVES

- A. Bronze Ball: Bronze cast body, chrome-plated full port ball, with handle, Teflon seat, 600 psi WOG, 150 psi steam; NIBCO 585-70.
- B. Lead Free Bronze Ball: Two-piece, full port, lead free silicon bronze body, Stainless steel or silicon bronze trim, Reinforced PTFE or TFE seats, 600 psi CWP NIBCO T/S-585-80-LF or T/S-585-66-LF, T/S-585HP-LF, or T/S-585HP-66LF.
- C. Bronze Ball, Clean Service: Bronze body, union fittings, bronze ball, self-cleaning, Buna-N ball seats 400 psi WOG factory cleaned, capped and bagged for oxygen service in accordance with CGA4.1 (Cleaning equipment for oxygen service) and NFPA 99, Ohmeda 207 Series.
- D. PVC Ball: PVC Body, trunnion mounted, Teflon seat, Viton seals; True Blue GSR Asahi.

2.03 BALANCING VALVE

- A. Lead-Free Manual Calibrated:
 - 1. Bronze, Ametal (copper-alloy), or ductile iron body, brass globe or ball, differential pressure readout valves with integral checks, calibrated plate, and integral pointer.
 - 2. Suitable for tight shutoff, memory stops, threaded, grooved or soldered ends, 250 psi water, NSF/ANSI 61 compliant.
 - 3. Bell and Gossett Lead-Free Circuit Setter Plus.
- B. Lead-Free Automatic (Zone Valve):
 - 1. Lead-Free brass body construction, self-balancing thermostatic zone valve. Valve proportionally modulates flow to maintain zone temperature set point.
 - 2. Field temperature adjustment from 100 degrees F to 160 degrees F, factory set to 110 degrees F.
 - 3. Integral check valve and strainer, cap on cold water port, three ball valve shut-offs, inlet temperature gauge and pipe union.
 - 4. Valve does not fully close, preventing circulation pump dead head condition.
 - 5. Acorn Controls TempFlow Thermostatic Zone Valve

2.04 WATER RELIEF VALVES

- A. Manufacturers:
 - 1. Consolidated
 - 2. Kunkle
 - 3. B&G
 - 4. Armstrong
 - 5. Cash Acme
 - 6. Other Manufacturers: Submit substitution request.
- B. Description: Bronze or steel body, stainless steel or bronze, pressure settings to 160 psi at 250 degrees F, conforming to Section IV of ASME Code, size per manufacturer's recommendations based on Code, setting as indicated; Kunkle Model 537.

2.05 STRAINERS

- A. Manufacturers:

1. General:
 - a. Armstrong
 - b. McAlear
 - c. Sarco
 - d. Steamflo
 - e. Mueller
 - f. R.P. & C. Company Titan Flow Control
 2. Grooved Coupling Systems:
 - a. Gruvlok
 - b. Victaulic
 3. Other Manufacturers: Submit substitution request.
- B. Wye Pattern:
1. Bronze: Bronze body, 250 psi, 1/16-inch perforated type 304 stainless screen.
 2. Ductile Iron: Ductile iron body, 300 psi, 1/16 or 1/8-inch 304 stainless steel screen.
 3. Cast Iron: Cast iron body, 125 psi, 1/16-inch perforated type 304 stainless screen.
 4. Cast Iron, High Pressure: Cast iron body, 250 psi, 1/16-inch perforated type 304 stainless screen.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide valves at connections to equipment where shown or required for equipment isolation.
- B. Provide separate support for valves where necessary.
- C. Provide drain valves in low points in the piping system, at coils and equipment, and as indicated.
- D. Coordinate gas pressure regulator selection with inlet pressure available at the regulator and the capacity and outlet pressure required by the equipment served.
- E. Install in accordance with manufacturer's recommendations.
- F. Locate gas cocks and gas regulator readily accessible for servicing.
- G. Provide approved gas cock immediately upstream of each gas pressure regulator.
- H. Provide separate vent to the outside for each regulator.

3.02 APPLIED LOCATIONS PLUMBING VALVES

- A. In piping 2-inches and smaller:

System	Valve Types				
	Gate	Globe	Swing Check	Ball	Butterfly
Domestic Hot	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Not Allowed
Domestic Cold	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Not Allowed

- B. Calibrated balancing valves on domestic hot water. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.
- C. Provide gauge cock for all pressure gauges.

3.03 VALVE IDENTIFICATION

- A. General: Identify valves to indicate their function and system served.
- B. Refer to Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.04 INSTALLATION

- A. Manual Air Vents:

1. Install at high points where automatic air vents are not used, where noted, and where required for proper venting of system.
2. Install in accordance with manufacturer's recommendations.
- B. Install grooved joints in accordance with the manufacturer's published installation instructions.
- C. Mold and produce gaskets by the coupling manufacturer, and suitable for the intended service. Coupling manufacturer's factory trained representative to provide on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products. Representative to periodically visit the project site to ensure best practices in grooved installation are being followed. Distributor's representative is not considered qualified to conduct the training of field visits.
- D. Test Plugs: Install where indicated and in accordance with the manufacturer's recommendations.
- E. Pressure Reducing Valves: Install where indicated and in accordance with manufacturer's recommendations with 3 valve bypass.
- F. Water Relief Valves:
 1. Install where indicated, and in accordance with manufacturer's instructions.
 2. Pipe discharge to nearest floor drain using Schedule 40 steel pipe.
- G. Strainer:
 1. Applied Locations Plumbing:
 - a. Bronze wye, in piping 2-inch and smaller; domestic water, solar hot water, reclaimed water, cold process water, process grey water.
 - b. Cast iron, in piping 2-1/2-inch and larger; solar hot water, reclaimed water, cold process water, process grey water
 - c. Cast-iron, high-pressure wye, in piping 2-1/2-inch and larger; domestic water.

END OF SECTION

MSTR/22 05 23/SKC

**SECTION 22 0529
HANGERS SUPPORTS AND ANCHORS FOR PLUMBING**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Supports, Anchorage and Restraint
 - 2. Pipe Attachments
 - 3. Insulation Protection Shields and Insulation Protection Saddles
 - 4. Building Attachments

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division twenty-two, Plumbing
- C. Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment
- D. Section 22 07 00, Insulation for Plumbing
- E. Section 22 21 13, Pipe and Pipe Fittings Plumbing

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Shop Drawings of contractor fabricated piping support structures.
 - 2. No other submittals required under this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Supports, Anchorage and Restraint:
 - 1. Unistrut
 - 2. Superstrut
 - 3. Powerstrut and Kinline
 - 4. B-Line Systems
 - 5. AnvilStrut
- B. Pipe Attachments:
 - 1. Anvil
 - 2. Superstrut
 - 3. B-Line Systems
 - 4. Tolco
 - 5. ERICO
- C. Building Attachments:
 - 1. Anvil as listed or equivalent products
 - 2. Elcen
 - 3. Superstrut
 - 4. B-Line Systems
 - 5. Tolco
 - 6. ERICO

2.02 SUPPORTS, ANCHORAGE AND RESTRAINT

- A. General:
 - 1. Provide pipe and equipment hangers and supports in accordance with the following:
 - a. Equipment, supports, and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor responsible for their design.

- b. Resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
 - c. Seismic restraint not to introduce excessive stresses in the piping caused by thermal expansion or contraction.
 - d. Connections to structural framing not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
 - e. In accordance with the latest edition of the SMACNA Seismic Restraint Manual - Guidelines for Mechanical Systems for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.
 - f. In accordance with the applicable code.
 - g. Follow provisions described in Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment.
- B. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.
 - C. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.
 - D. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.03 PIPE ATTACHMENTS

- A. Uninsulated Horizontal Copper Piping:
 - 1. 2-inch and Smaller: Anvil CT-65, CT-69, CT-99C.
 - 2. Larger than 2-inch:
 - a. Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods.
 - b. Electricians' tape is unacceptable.
- B. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.
- C. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:
 - 1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
 - 2. Larger than 2-inch: Anvil 260.
- D. Other Uninsulated Horizontal Pipe:
 - 1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
 - 2. Larger than 2-inch: Anvil 260.
- E. Other Insulated Horizontal Pipe with Hangers Inside of Insulation:
 - 1. 2-inch and Smaller: Anvil 65, 70, 104, 260 or 300.
 - 2. Larger than 2-inch: Anvil 260.
- F. Other Insulated Horizontal Pipe with Hangers Outside of Insulation:
 - 1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
 - 2. Larger than 2-inch: Anvil 260.
- G. Riser Clamps Copper Pipe:
 - 1. 4-inch and Smaller: Anvil CT-121, CT-121C or 261C.
 - 2. Larger than 4-inch: Anvil 261C.
- H. Riser Clamps Other Piping: Anvil 261.

2.04 INSULATION PROTECTION SHIELDS AND INSULATION PROTECTION SADDLES

- A. Insulation Protection Shields: Anvil 167
- B. Insulation Protection Saddles: Anvil 160 through 166A as required. Saddles for copper pipe, factory, or field copper plated.

2.05 BUILDING ATTACHMENTS

- A. Beam Hangers:
 - 1. On piping 6-inch and smaller: Anvil 86 with retaining clip Figure 89.

2. On piping larger than 6-inch: Anvil 228, or 292.
- B. Inserts:
 1. Anvil 152 malleable iron or 281 steel inserts.
 2. Inserts sized for required rod to support load being carried.
- C. Expansion Plugs: Similar and equal to Phillips red-head self-drilling flush shell selected for safety factor of 4.
- D. Powder actuated fasteners with silencers as approved by Architect.

PART 3 EXECUTION

3.01 HANGERS AND SUPPORTS

- A. General:
 1. Install support systems as detailed and in accordance with manufacturer's recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required, and as detailed on the Drawings.
 2. Provide adjustable hangers for pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
 3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
 4. Except as otherwise indicated for exposed continuous pipe runs, install hangers, and supports of same type and style as installed for adjacent similar piping.
 5. Install cast iron piping in accordance with Cast Iron Soil Pipe Industry (CISPI) Standards.
 6. Support piping within 2-feet of each change of direction on both sides of fitting.
- B. Insulated Piping Systems:
 1. Refer to Section 22 07 00, Insulation for Plumbing for insulation requirements.
 2. Insulated Piping Systems with Vapor Barrier Insulation:
 - a. Install hangers outside of insulation.
 - b. On piping 1-1/2-inch and larger, provide insulation protection shields at each support location.
 3. Insulated Piping Systems with Non-Vapor Barrier Insulation:
 - a. At the contractor's option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.
 - b. If hangers are installed outside of insulation, provide insulation protection shields at support locations on piping 1-1/2-inch and larger.
 - c. On piping larger than 2-inch, provide insulation saddles at each support location.
- C. Vertical Piping:
 1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
 2. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.
 3. Risers that are not subject to thermal change to be supported at each floor of penetration.
 4. Risers that are subject to thermal change require engineered supports. Size supports to carry forces exerted by piping system when in operation. Riser supports follow provisions described in Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment.
- D. Horizontal Piping:
 1. Trapeze Hangers:
 - a. Multiple pipe runs where indicated supported on channels with rust resistant finish.

- b. Provide necessary rods and supporting steel.
- 2. Horizontal PEX-a Piping with PEX-a Pipe Channel: Install hangers for PEX-a piping with horizontal support channel in accordance with local jurisdiction and manufacturer's recommendations.
- 3. Support Spacing:
 - a. Provide support at minimum spacing per MSS SP-69-1996 Pipe Hangers and Supports - Selection and Application:
 - 1) Support piping within 2-feet of each change in direction.
 - 2) Steel Pipe, Copper Tubing:

Minimum Pipe Size	Maximum Span Steel	Maximum Span Copper	Maximum Span Pex A pipe with Pex a Pipe Channel	Rod Size
1-inch and smaller	7-feet	5-feet	6-feet	1/4-inch
1-1/4-inch to 2-inch	8-feet	8-feet	8-feet	3/8-inch
2-1/2-inch to 3-inch	11-feet	9-feet	8-feet	1/2-inch

- 3) Plumbing Piping: Support in accordance with local plumbing code.
- 4) Plastic Pipe: Supported a maximum of 3-feet on center for piping 1-inch and smaller and 4-feet on center for piping 1-1/4-inch and larger with rod sizes as recommended by the manufacturer.
- 5) Piping provided with acoustical lagging wrap supported a maximum of 5-feet on center. Install hangers outside of acoustical lagging.

E. Building Attachments:

- 1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
- 2. Provide horizontal bracing on horizontal runs 1-1/2 inch and larger and exceeding 50-feet in length at 75-foot intervals and as required to provide stabilized piping systems.
- 3. Provide additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
- 4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

END OF SECTION 22 0529

**SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Valve Identification
 - 2. Piping Markers
 - 3. Equipment Identification

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 22, Plumbing

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
 - 2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
 - 3. Operating and Maintenance Data: Include a copy of valve tag and equipment nameplate directories in each set of Operating and Maintenance manuals.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Piping Markers:
 - 1. W.H. Brady
 - 2. Seton
 - 3. Marking Systems, Inc. (MSI)
 - 4. Other Manufacturers: Submit substitution request.

2.02 VALVE IDENTIFICATION

- A. Valve Tags:
 - 1. General: Identify valves with metal tags, legends to be stamped or embossed. Indicate function of the valve and its normal operating position.

56 HW	(NUMBER AND CONTENT OF PIPE)
ISOLATION	(VALVE FUNCTION)
NO	(NORMAL OPERATION POSITION)
 - 2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
 - 3. Material: Use 0.04-inch brass tags.
 - 4. Automatic Valves and Regulating Valves: Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, lamicaid, or equal. Form letters by exposing center ply.
 - 5. Buildings Systems: Contact the Owner for coordination with existing building tagging system and supplementary information required for specific systems before valve tagging begins.
- B. Valve Tag Directory: Include tag number, location, exposed or concealed, service, valve size, valve manufacturer, valve model number, and normal operating position of valve.

2.03 PIPING MARKERS

- A. Label pipes with all-vinyl, semi-rigid plastic or strap-on labels.
- B. For pipes O.D. smaller than 3/4-inch and for valve and fitting identification, use valve tag.
- C. For sizes from 3/4 to 1-1/4-inch outside diameter, 1/2-inch letters, 8-inch marker width.

- D. For sizes from 1-1/2 to 2-inch outside diameter, 3/4-inch letters, 8-inch marker width.
- E. Identify and color-code pipe markers as follows with directional arrows.

PLUMBING SERVICE	PIPE MARKER*	BACKGROUND/TEXT COLOR
COLD WATER	DOMESTIC COLD WATER	GREEN/WHITE
HOT WATER	DOMESTIC HOT WATER SUPPLY	GREEN/WHITE
	DOM. HOT WATER RECIRC	GREEN/WHITE
SANITARY WASTE	SANITARY WASTE	GREEN/WHITE
STORM DRAIN	STORM DRAIN	GREEN/WHITE
OVERFLOW DRAIN	OVERFLOW DRAIN	GREEN/WHITE
VENT	VENT	GREEN/WHITE

2.04 EQUIPMENT IDENTIFICATION

- A. Nameplates:
1. Tag pumps, converters, and miscellaneous mechanical equipment items with engraved nameplates.
 2. 1/16-inch thick, 3-inch by 5-inch laminated 3-ply plastic, center ply white, outer ply black. Form letters by exposing center ply.
 3. Identify unit with code number as shown on Drawings and area served.

PART 3 EXECUTION

3.01 VALVE IDENTIFICATION

- A. Valve Tags:
1. Attach to valve with a brass chain.
 2. Continuous valve tag numbers throughout the building for each system. Obtain a list for each system involved from the [Owner] [to establish numbers following the listed sequences.]
- B. Valve Tag Directory: Post final copy in Operation and Maintenance Manual.

3.02 PIPING MARKERS

- A. Unless recommendations of ANSI A13.1 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:
1. Every 20-feet along continuous exposed lines.
 2. Every 10-feet along continuous concealed lines.
 3. Adjacent to each valve, flange, and stub-out for future.
 4. On pipe before and after wall, floor, and ceiling penetrations.
 5. On pipe into and out of concealed spaces.
 6. Adjacent to changes in pipe direction.
 7. On each riser.
 8. Adjacent to each leg of a T.
 9. Locate conspicuously where visible. Position pipe labels on pipe to achieve the best visibility.
 10. Apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above.
- B. Apply arrow labels indicating direction of flow.

3.03 EQUIPMENT IDENTIFICATION

- A. Nameplates: Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.

B. Nameplate Directory: Post final copy in Operation and Maintenance Manual.
END OF SECTION 22 0553

**SECTION 22 0590
PRESSURE TESTING FOR PLUMBING SYSTEMS**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Pressure Testing of Piping System

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 22, Plumbing

1.03 QUALITY ASSURANCE

- A. Code Compliance: Perform required tests in the presence of the authority having jurisdiction.
- B. Owner Witness: Perform all tests in the presence of the Owner's representative.
- C. Engineer Witness: The Engineer or Engineer's representative reserves the right to observe all tests or selected tests to assure compliance with the specifications.
- D. Simultaneous Testing: Test observations by the authority having jurisdiction, the Owner's Representative, and the Engineer's representative need not occur simultaneously.

1.04 SUBMITTALS

- A. Submit the following test reports:
 - 1. Certificate of completion, inspection, and test by authority having jurisdiction on required piping systems.
 - 2. Certificate of test approval by Owner's representative on all systems.
 - 3. Engineer's representative will record witnessed tests.

PART 2 PRODUCTS – NOT APPLICABLE

PART 3 EXECUTION

3.01 GENERAL

- A. Piping:
 - 1. Test prior to concealment, insulation being applied, and connection to equipment, fixtures, or specialties.
 - 2. Conduct tests with all valves but those used to isolate the test section 10 percent closed.
- B. Leaks: Repair leaks and retest until stipulated results are achieved.
- C. Notification:
 - 1. Advise the Architect 72 hours in advance of each test.
 - 2. Failure to so notify will require test to be rescheduled.
- D. Testing Equipment: Provide all necessary pumps, gauges, connections, and similar items required to perform the tests.

3.02 TESTING REQUIREMENTS

- A. Sanitary and Roof Drainage Systems:
 - 1. Test entire system or sections of system by closing all openings in piping except highest opening and filling system with water to point of overflow. If system is tested in sections, plug each opening except highest opening of section under test and fill each section with water, but none with less than 10 feet head of water.
 - 2. Keep water in system or in portions under test for at least 45 minutes before inspection starts. Test for 2 hours with no drop allowed. Locate and repair leaks.
- B. Domestic Water Systems:

1. Test entire system by closing all openings in piping except highest opening and filling system with water to point of overflow.
2. Keep water in system under test for a minimum of 45 minutes before inspection starts.
3. Test at full working pressure for 2 hours with no drop allowed. Locate and repair leaks.

END OF SECTION 22 0590

SECTION 22 0593
TESTING, ADJUSTING AND BALANCING FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Domestic Hot Water Recirculation Systems
 - 2. Pumping Systems

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 22, Plumbing

1.03 QUALITY ASSURANCE

- A. Testing and Balancing Firm Qualifications:
 - 1. Procure the services of an independent balance and testing agency, approved by the Architect, which specializes in the balancing and testing of plumbing, heating, ventilating, and air conditioning systems, to balance, adjust and test water circulating and air moving equipment and air distribution or exhaust systems as herein specified.
 - 2. Testing agency to provide proof of having successfully completed at least five projects of similar size and scope.
 - 3. Certification: National Environmental Balancing Bureau (NEBB)
- B. Industrial Standards:
 - 1. NEBB, American Society of Heating, Refrigerating
 - 2. Air Conditioning Engineers (ASHRAE)
 - 3. American National Standards Institute (ANSI) as follows:
 - a. NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
 - b. ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
 - c. ANSI:
 - 1) S1.4 Specifications for sound level meters.
 - 2) S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.
- C. Instrument Certification: Instruments used accurately calibrated and certified within six months of balancing and maintained in good working order.
- D. Test Observation: If requested, conduct test in the presence of the Architect or the Architect's representative.
- E. Pre-Balancing Conference:
 - 1. Review with the Engineer prior to starting balancing, general techniques.
 - 2. Conference must occur prior to measuring existing conditions.
 - 3. Measuring of existing conditions must occur prior to any demolition or new work.
 - 4. Review existing conditions and systems to be affected by the project

1.04 SUBMITTALS

- A. Submit the following:
 - 1. Balancing Log:
 - a. Include water outlets, actual field measured water volume, and percentage of design volumes.
 - b. Provide drawings identifying location of outlets.

2. Equipment Data Sheets:
 - a. Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
 3. Additional Data: Submit additional data as provided by Associated Air Balance Council (AABC) Standard forms.
 4. Number of Copies: Submit six copies of the above completed information to the Engineer for review and insertion into the Operating and Maintenance Data.
 5. Instrument Certification: When requested, submit certificate of calibration for equipment to be used.
- B. Record data on NEBB forms or forms approved by the Architect.

1.05 PROJECT CONDITIONS

- A. Where existing systems are to be adjusted, establish flow rates in all branches prior to making any modifications to system. Submit preliminary report indicating existing conditions prior to making any modifications to existing systems. Adjust central equipment as required and restore unmodified branches and outlets to original condition. Obtain existing system drawings from Owner and become familiar with extent and nature of existing systems.
- B. Do not perform final testing, adjusting, and balancing work until equipment has been completely installed and operating continuously as required.
- C. Conduct testing and balancing with clean strainers and filters in place. Clean strainers, etc., prior to performing hydronic testing and balancing.

1.06 WARRANTIES

- A. In addition to the Requirements of the Contract, include an extended warranty of six months after completion of test and balance work during which time the Architect at his discretion may request a recheck or resetting of any equipment or device listed in the test reports.

PART 2 PRODUCTS – NOT APPLICABLE

PART 3 EXECUTION

3.01 DOMESTIC HOT WATER RECIRCULATION SYSTEMS

- A. General: Make measurements in accordance with Industrial Standards specified above. Record on appropriate forms.
- B. Preliminary:
 1. List complete data of tested equipment and verify against Contract Documents.
 2. Open line valves to full open position.
 3. Set master mixing valve as described by manufacturer's recommendations to achieve desired leaving water temperature.
 4. For each pump:
 - a. Verify rotation.
 - b. Test and record pump shut-off head.
 - c. Test and record pump wide-open head.
 5. Verify proper system pressures.
- C. Distribution:
 1. Read and adjust water flow for design conditions.
 2. Set memory stops and mark position of adjuster on balancing valves.

3.02 DOMESTIC HOT WATER POINT OF USE MIXING VALVES

- A. General: Make measurements in accordance with Industrial Standards specified above. Record on appropriate forms.
- B. Preliminary:
 1. List complete data of tested equipment and verify against Contract Documents.

2. Open line valves to full open position.
- C. Distribution:
 1. Adjust water flow for design conditions.
 2. Set mixing valve to achieve desired leaving water temperature.
 3. Set memory stops and mark position of adjuster on balancing valves.

3.03 COORDINATION

- A. Coordinate work with other trades to ensure rapid completion of the project.
- B. Deficiencies noted during the course of balancing in the mechanical installation promptly reported to the Architect to allow corrective action to proceed.
- C. Provide periodic review of progress as requested.

END OF SECTION 22 0593

**SECTION 22 0700
INSULATION FOR PLUMBING**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Pipe Insulation
 - 2. Pipe Acoustical Wrap
 - 3. Block Insulation
 - 4. Accessories Piping

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 22, Plumbing
- C. Section 22 05 29, Hangers, Supports and Anchors for Plumbing

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Insulating products prohibited from containing pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
 - 2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723 or ASTM E84.
 - 3. Energy Codes: Local Building and Energy Codes govern where insulation performance requirements for thickness exceeds thickness specified.
- B. Protection: Protect against dirt, water, chemical, or mechanical damage before, during, and after installation. Repair or replace damaged insulation at no additional cost.
- C. Source Quality Control:
 - 1. Service: Use insulation specifically manufactured for service specified.
 - 2. Labeling: Insulation labeled or stamped with brand name and number.
 - 3. Insulation and accessories not to provide nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin. Asbestos free and no interaction with corrosively with equipment, piping, or ductwork.

1.04 SUBMITTALS

- A. Submit the following.
 - 1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. General:
 - 1. Johns Manville
 - 2. Knauf
 - 3. Owens Corning
 - 4. CertainTeed
 - 5. Such insulation by one manufacturer.
 - 6. Other Manufacturers: Submit substitution request.
- B. Pipe Insulation:

1. Fiberglass:
 - a. Johns Manville Microlok HP
2. Calcium Silicate:
 - a. Johns Manville Thermo-12 Gold
3. Elastomeric:
 - a. Armacell AP Armaflex
 - b. Rubatex
 - c. K-Flex
- C. Pipe Acoustical Wrap:
 1. Sound Seal
- D. Block Insulation:
 1. Johns Manville 1000 Series
- E. Accessories Piping:
 1. Adhesives:
 - a. Calcium Silicate: Benjamin Foster 30-36.
 - b. Elastomeric: Armacell 520 BLV.
 2. Cements:
 - a. Insulating: Ryder.
 - b. Heat Transfer: Chemax Tracit-300.
 3. Pipe Fitting Covers:
 - a. Zeston, Ceel-Co.
 4. Grooved Coupling Insulation:
 - a. Zeston, Ceel-Co.
 5. Tapes:
 - a. Zeston Z-tape.

2.02 PIPE INSULATION

- A. Fiberglass: Split sectional or Snap-On type with 0.23 per inch maximum thermal conductivity (K-factor) at 75 degrees F mean temperature, 850 degrees F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system.
- B. Calcium Silicate: Sectional with 14 pcf nominal density, 0.40 maximum K-factor at 300 degrees F mean temperature and 1200 degrees F maximum service rating.
- C. Elastomeric:
 1. Expanded closed cell, 0.27 per inch maximum K-factor at 75 degrees F mean temperature, 220 degrees F maximum service rating with fitting covers and paintable surface.
 2. Color:
 - a. Concealed Locations: Black
 - b. Exposed Locations: White.

2.03 PIPE ACOUSTICAL WRAP

- A. Barrier
 1. Nominal density of 2 pound per square foot vinyl noise barrier with reinforced foil facing on one side
 2. Minimum thermal conductivity value of 0.29 and a rated service temperature range of -20 degrees F to 220 degrees F.
- B. Decoupling Layer:
 1. 1-inch-thick acoustical fiberglass quilted with a non-porous scrim facing.
- C. Composite Material:
 1. Fabricated to include a nominal 6-inch-wide barrier overlap tab extending beyond the quilted fiber glass to facilitate a leak-tight seal around field joints.
- D. Performance:

1. Minimum STC rating of 29 when tested in accordance with ASTM E90 and E413.
 2. Flame spread index of less than 25 and a smoke-development index of less than 50 when tested in accordance with ASTM E84 or UL 723.
- E. Accessories for securely mounting the Acoustical pipe and duct lagging
1. Foil lag tape
 2. Stick pins
 3. Welding pins
 4. Banding

2.04 BLOCK INSULATION

- A. Fiberglass: 1-1/2-inch thick unless specified or shown otherwise with 3 pcf nominal density, 0.23 per inch maximum K-factor at 75°F mean temperature and 450°F maximum operating temperature limit.

2.05 ACCESSORIES PIPING

- A. Adhesives:
1. General: Maximum Flame Spread/Smoke Developed Rating of 25/50, SCAQMD Rule 1168 compliant.
 2. Fiberglass: Integral closure system.
- B. Wire Mesh: 1-inch mesh with 20-gauge annealed steel wire.
- C. Pipe Fitting Covers: One piece PVC insulated pipe fitting covers.
- D. Grooved Coupling Insulation: One piece PVC insulated fitting cover.
- E. Metal Pipe Jacket: 0.016-inch-thick aluminum jacket with formed fitting covers, aluminum snap straps and sealant.
- F. Cloth Facing: Presized fiberglass cloth.
- G. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F.
- H. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

PART 3 EXECUTION

3.01 GENERAL

- A. Workmanship:
1. Installation: Insulation installed in first class, neat professional manner.
 2. Applicators: Employed by firm that specializes in insulation work.
- B. Preparation: Surfaces of piping and equipment clean, free of oil or dirt, and dry before insulation is applied.
- C. Stamps: ASME stamps, UL labels, and similar stamps and labels are not covered.

3.02 PLUMBING PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

- A. Insulation Applied Locations – Plumbing Piping:

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Domestic Cold Water, Above Grade	1-1/4-inch and smaller	Fiberglass, all-purpose jacket or Elastomeric	1-inch	Note 1 Note 2
Domestic Cold Water, Above Grade	Above 1-1/4-inch	Fiberglass, all-purpose jacket	1 1/2-inch	Note 1
Domestic Hot Water Supply/Return,	1-1/4-inch and smaller	Fiberglass, all-purpose jacket or Elastomeric	1-inch	Note 1 Note 2

Above Grade				
Domestic Hot Water Supply/Return, Above Grade	1-1/2-inch and larger	Fiberglass, all-purpose jacket	1 1/2-inch	Note 1
Domestic Hot Water Supply/Return, Above Grade	2-inch and smaller	Fiberglass, all-purpose jacket	Not less than the diameter of the pipe	Note 1
Sanitary Waste Piping, Exposed Over First Floor		Elastomeric	1"	
Interior Storm Drain and Interior Overflow Drains	All	Fiberglass, all-purpose jacket	1/2-inch	Note 3
Traps and trap priming lines (In unheated Spaces)	All	Fiberglass, all-purpose jacket	1-inch	Insulate over heat tape
Condensate or other cold water drains	All	Elastomeric	1/2-inch	Note 2
<p>Note 1: Cover with metal pipe jacket where exposed to weather, and over heat trace cable. Note 2: Elastomeric insulation not allowed over heat trace cable. Note 3: Drain bodies, insulate the first 10-feet connected to the drain body, and horizontal piping. Do not insulate main vertical stack.</p>				

- B. The following piping is not insulated:
1. Domestic cold water runouts to single fixture less than 12-inch long and exposed supplies.
 2. Priming lines except where heat traced.
- C. Insulation includes the following:
1. Fittings
 2. Unions
 3. Flanges
 4. Mechanical Couplings
 5. Valve Bodies
 6. Valve Bonnets
 7. Piping through Sleeves except Valve Bonnets
 8. Unions and Flanges need not be insulated on the following systems:
 - a. Domestic Hot Water
 - b. Inside Building
- D. Insulate valves and irregular fittings with section of pipe insulation and insulating cement, securely fastened, and finished with 6 oz. canvas and Foster 30-36 lagging adhesive.
- E. Flanges, valves, strainers, not requiring a vapor barrier to insulate with removable replaceable pads fabricated of 1-inch layer of Pittsburgh Corning Temp Mat sandwiched between inner and outer layer of 8 oz. glass cloth held together with stainless staples with sufficient stainless lacing hooks to hold pad firmly to flange or valve with minimum 3-inch overlap onto adjacent pipe insulation using 18 gauge SS lacing wire.
- F. Expansion Joints and Flexible Connectors: Pipe insulation or block of same material and thickness as adjacent piping.

3.03 PIPING INSTALLATION

- A. General:
 - 1. Joints: Coat both sides of complete joining area with applicable adhesive.
 - a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch-wide tape.
 - b. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch-wide tape or butt straps.
 - c. Multiple Layered Insulation: Joints staggered.
 - 2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
 - 3. Voids:
 - a. Fill voids, chipped corners and other openings with insulating cement or material compatible with insulating material.
 - b. In insulation with heat tracing where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
 - 4. Seal joints, seams, and fittings of metal watertight jackets at exterior locations.
- B. Fiberglass Insulation: Exterior insulation encased in metal jacket.
- C. Calcium Silicate Insulation:
 - 1. Secure with 18-gauge wire embedded into insulation.
 - 2. Cover with continuous vapor barrier jacket.
- D. Elastomeric Insulation:
 - 1. Slit full length and snap around pipe.
 - 2. Make cuts perpendicular to insulating surface leaving no cut section exposed.
 - 3. Do not stretch insulation to cover joints or fittings.
 - 4. Seal joints in elastomeric insulation with adhesive.
 - 5. Exterior insulation painted with two coats of specified paint in accordance with the manufacturer's instructions and encase in metal jacket.
 - 6. Sealing joints with tape will not be allowed.
- E. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.
 - 1. On Elastomeric Insulation: Fittings covered with covers made up of mitered sections of insulation or with formed pipe fitting covers.
 - 2. In Other Insulation: Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.
- F. Unions, Mechanical Joints, Valves, Etc.:
 - 1. General:
 - a. As specified for fittings.
 - b. Minimum thickness same as specified for piping.
 - 2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.
 - 3. Flanges: With square corners. Where flanges are not insulated, terminate adjacent insulation so flange bolts can be removed.
 - 4. Flanged Valves: Insulation with square corners.
- G. Vapor Barrier Insulation:
 - 1. Refer to Section 22 05 29, Hangers, Supports, and Anchors for Plumbing for support requirements.
 - 2. Piping which requires vapor barrier protection of continuous vapor barrier, which may not be pierced or broken. The following piping systems require vapor barrier protection:
 - a. Domestic cold water.

- b. Industrial cold water.
 - c. Non-potable cold water.
 - d. Other piping systems with a nominal operating temperature below 65 degrees F.
3. Vapor Barrier Insulation:
- a. Insulation for pipe requiring vapor barrier protection 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.
 - b. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation with continuous vapor barrier jacket at each hanger or roller. Provide pipe shield specified in Section 22 05 29, Hangers, Supports, and Anchors for Plumbing.
- H. Non-Vapor Barrier Insulation:
- 1. Refer to Section 22 05 29, Hangers, Supports, and Anchors for Plumbing for support requirements.
 - 2. At contractor's option, insulation may be interrupted at supports. Butt insulation tight to support.
 - 3. If contractor elects to continue insulation at supports, installation as specified for piping systems with vapor barrier installation.
 - 4. Void between saddle and pipe filled with insulation.

3.04 EQUIPMENT INSTALLATION

- A. General: Install true and smooth. Insulation over curved surfaces conform to curves of surface.
- 1. Access:
 - a. Insulated removable heads, water boxes, pump casings, access, etc., that require service, inspection or maintenance provided with covers or section that are easily removable and replaceable.
 - b. Reinforce openings in adjacent insulation with metal beading. In vapor barriered insulation, coat joints with vapor barrier mastic.
 - 2. Voids, Depressions and Cavities: Fill voids, chipped corners, and other openings with insulating cement or material compatible with insulating material.
 - 3. Vapor Barrier Insulation: Barrier not to be pierced or broken.
 - a. Coat defects with vapor barrier mastic and patched with insulation facing or tape.
 - b. Staples brush coated with vapor barrier coating.
 - c. Cover raw edges coated with vapor barrier mastic sealed to equipment surface.
 - 4. Non-Vapor Barriered Insulation:
 - a. Patch tears with insulation facing or tape.
 - b. Cover and neatly bevel raw edges to equipment surface.
 - 5. Multilayered Insulation: With staggered joints.
- B. Fiberglass Block:
- 1. Anchors: Lug nuts 10-gauge black annealed iron wire welded to metal surfaces.
 - 2. Banding: Block secured to surface with 1/2-inch-wide stainless steel bands maximum 18-inches on center and secured to anchors.
 - 3. Insulating Cement: Block covered with insulating cement minimum thickness of 1/2-inch with smooth finish.
 - 4. Vapor Barrier System: Apply continuous coat of vapor barrier mastic.
 - 5. Finish: Finish with cloth facing secured with adhesive and lapped a minimum of 2 inches. Defects touched up with finishing cement.
- C. Elastomeric Blanket:
- 1. Cut insulation to size, make corners with mitering cuts to preclude raw edges, continuously cement insulation to equipment with adhesive.

2. Cement both surfaces of joints and butt tightly together and cover raw edges with two coats of adhesive.
- D. Expansion Joints: Covered with larger size pipe insulation to allow full movement and be removable, ends turned back to pipe, coat with vapor barrier mastic on joints in vapor barriered system, and finished with cloth facing cemented to insulation with adhesive.
- E. Heat Exchangers: Insulation thickness and material as specified for piping and applicable service.

3.05 FIELD QUALITY CONTROL

- A. Field Test: Test and approve systems prior to installation of insulation.
- B. Existing Insulation:
 1. Repair existing insulation damaged during construction.
 2. Make neat connections where new and existing insulation meet.
 3. Where existing piping, or equipment is removed, cover existing surfaces neatly to match existing.

END OF SECTION 22 0700

**SECTION 22 2113
PIPE AND PIPE FITTINGS PLUMBING**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Cast Iron Soil Pipe, Service Weight (No-Hub)
 - 2. Copper Pipe
 - 3. PEX Potable Water Tubing
 - 4. Unions
 - 5. Mechanical Pipe Couplings and Fittings
 - 6. Solder and Brazing
 - 7. Pipe Wrapping
 - 8. Flexible Connector

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 22, Plumbing
- C. Section 22 05 29, Hangers, Supports, and Anchors for Plumbing
- D. Section 22 25 00, Plumbing Water Treatment
- E. Section 22 05 23, General Duty Valves for Plumbing

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Piping material and installation to meet requirements of the local plumbing, fire, and building codes and serving utility requirements.
 - 2. Provide chlorination of domestic cold and hot water piping in accordance with County and State health requirements.
- B. Grooved Joint Couplings and Fittings:
 - 1. Products of a single manufacturer.
 - 2. Grooving tools of the same manufacturer as the grooved components.
 - 3. Castings used for coupling housings, fittings, valve bodies, etc., date stamped for quality assurance and traceability.
- C. Pipe Cleaning: If pipe gets plugged or should foaming of water systems occur, disconnect piping, reclean, and reconnect without additional expense to the Owner.
- D. Correct damages to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.
- E. Products with a wetted surface installed in potable water systems UL classified in accordance with ANSI / NSF-61 for Drinking Water System components, ANSI/NSF-14 for Plastic Piping System Components and certified to the low lead requirements of NSF-372.

1.04 SUBMITTALS

- A. Submit the following:
 - 1. List of piping materials indicating the service it is being used for. (Do not submit piping product data).
 - 2. Product data on mechanical couplings and related components, double wall fuel oil pipe and fittings, and polypropylene waste and vent pipe.
- B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.
- C. Other: Make certified welders' certificates available.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. As indicated.

2.02 CAST IRON SOIL PIPE, SERVICE WEIGHT (NO-HUB)

- A. General: A code approved hubless system conforming to Cast Iron Soil Pipe Institute Standard 301.
- B. Pipe and Fittings:
 - 1. Service weight hubless cast iron conforming to ASTM A 888, marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International.
 - 2. Manufacturers:
 - a. Tyler
 - b. AB&I
 - c. Charlotte
- C. Gaskets: Compression type conforming to ASTM C 564.
- D. Above Grade Couplings: Band type coupling in conformance with Cast Iron Soil Pipe Institute (CISPI) 310-90, consisting of stainless-steel clamp, and corrugated shield assemblies with a neoprene sealing sleeve ANSI A21.6, ANSI A21.10 Fittings.

2.03 COPPER PIPE

- A. Pipe: Hard drawn copper tubing (unless otherwise noted),
 - 1. Type M, L, or K: ASTM B 88
 - 2. Type DWV: ASTM B 306
- B. Fittings:
 - 1. Wrought copper, 150 psi; ANSI B16.22 for soldered joints, ANSI B16.50 for brazed joints; Chase, Revere, Mueller or approved equal.
 - 2. System using mechanically extracted collars in main with branch line inserted to not obstruct flow may be used on domestic water piping above ground, similar to T-drill.
 - 3. Refer to Solder and Brazing Section below.
- C. Joints:
 - 1. Soldered:
 - a. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
 - b. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.
 - c. Applied locations:
 - 1) Piping 2 inches and smaller above grade
 - 2. Brazed:
 - a. Wrought Copper Piping Fittings: Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.
 - b. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
 - c. Applied locations:
 - 1) Copper piping larger than 2 inches above grade
 - 2) Piping below grade
- D. Service:
 - 1. Type M:
 - a. Trap primer lines (above ground)
 - b. Drains and Overflows (clear, condensate)
 - 2. Type L:

- a. Domestic, Industrial, Solar, Reclaimed Water (above grade)
- 3. Type K:
 - a. Domestic, Industrial, Solar, Reclaimed Water (below grade)
 - b. Pumped Waste, Pumped Storm (below grade)
- 4. Type DWV: (not to be used on pressure systems)
 - a. Drains and overflows (clear, condensate)

2.04 PEX POTABLE WATER TUBING

- A. Manufacturers:
 - 1. Uponor (aka Wirsbo)
 - 2. Other Manufacturers: Submit substitution request.
- B. Regulatory Listings: Submit appropriate NSF International, UL, Warnock Heseey, or CSA listings as proof of compliance with local building and plumbing codes.
- C. PEX tubing and components installed in full compliance with local jurisdictional codes, standards, and requirements.
- D. Submit listings that indicated that the PEX tubing system has been certified to ANSI/NSF Standards 14 and 61.
- E. Quality Assurance:
 - 1. Installer Qualifications: Installer experienced in performing work of this Section who has specialized in installation of work similar to that required for this project.
 - 2. Provide in writing to the Owner that the PEX tubing and components furnished under this Section conforms to the material and mechanical requirements specified herein.
 - 3. Provide letters of certification indicating: Installer uses skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed trades person.
- F. Materials:
 - 1. Tube Materials:
 - a. Cross-linked polyethylene (PEX) manufactured by PEX-A or Engle method.
 - b. Provide blue colored PEX for cold water systems and red colored PEX for hot water systems for pipe size 1/2-inch thru 1 inch.
 - 2. Tubing Type:
 - a. PEX tubing manufactured in accordance with ASTM F876, ASTM F877 and CAN/CDA-B137.5.
 - b. Listed to ASTM by an independent third-party agency.
 - 1) PEX tubing to have Standard Grade hydrostatic design and pressure ratings of 200 degrees F at 80 psi and 180 degrees F at 100 psi. Temperature and pressure ratings issued by the Plastic Pipe Institute (PPI) report TR-4/06.
 - 2) Minimum bend radius for cold bending of the PEX tubing not less than 6 times the outside diameter. Bends with the radius less than stated requires the use of a bend support as supplied by tube manufacturer.
 - 3. PEX-a Fittings: elbows, adapters, couplings, plugs, tees and multi-port tees (1/2 inch through 3-inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:
 - a. UNS No. C69300 Lead-free (LF) Brass.
 - b. 20 percent glass-filled polysulfone as specified in ASTM D 6394.
 - c. Unreinforced polysulfone (Group 01, Class 1, Grade 2) as specified in ASTM D 6394.
 - d. Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D 6394.
 - e. Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D 6394.

- f. Reinforcing cold-expansion rings manufactured from the same source as PEX-a piping manufacturer and marked F1960.
- 4. Multi-Port Tees: Multiple outlet fitting complying with ASTM F 877; with ASTM F 1960 inlets and outlets.
 - a. Engineered polymer branch multi-port tee.
 - b. Engineered polymer flow-through multi-port tee.
 - c. Engineered polymer commercial branch multi-port tee.
 - d. Engineered polymer commercial branch multi-port elbow.
 - e. Engineered polymer commercial flow-through multi-port tee.
- 5. Manifolds: Multiple-outlet assembly complying with ASTM F 877; with ASTM F 1960 outlets.
 - a. Engineered polymer valved manifold.
 - b. Engineered polymer valve less manifold.
 - c. Lead - free copper branch manifold.
 - d. Lead-free copper valved manifold.
- 6. PEX-to-Metal Transition Fittings:
 - a. Manufacturers: Provide fittings from the same manufacturer of the piping.
 - b. Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
 - c. Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
 - d. PEX-a to Flange Transition: two-piece brass fitting with lead-free ProPEX adapter and steel flange conforming to ASME B 16.5.
 - e. PEX-to-Thermoplastic Transition Fittings: CPVC to PEX-a Transition: Thermoplastic fitting with one spigot or socket end and one ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
- G. Accessories:
 - 1. Wall Penetration Brackets: Brackets designed for wall membrane penetrations supplied by PEX tubing manufacturer; Uponor Drop Ear Bend Support.
 - 2. Concrete Tube Support Brackets: Brackets to hold PEX tubing in place in structural concrete slabs rigid PVC construction and be designed for that purpose.
 - 3. Uponor Stand-Up bracket.
- H. Service:
 - 1. Domestic hot and cold-water piping above grade on piping 3 inches and smaller.
 - 2. Industrial cold water above grade on piping 3 inches and smaller.
 - 3. Reclaimed cold water above grade on piping 3 inches and smaller.
 - 4. Trap priming lines below grade.

2.05 UNIONS

- A. 150 psi malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe. 200 psi WOG bronze, ground joint, solder type for copper tubing.
 - 1. Unions or flanges for servicing or disconnect are not required in installations using grooved mechanical joint couplings. Couplings serve as disconnect points.
- B. Dielectric fittings nationally listed, have a dielectric thermoplastic interior lining, and meet requirements of ASTM F1545. Fittings suitable for the pressure and temperature to be encountered.

2.06 MECHANICAL PIPE COUPLINGS AND FITTINGS

- A. Manufacturers:
 - 1. Victaulic

2. Anvil Gruvlok 7401, 7001
 3. Other Manufacturers: Submit substitution request.
- B. Coupling: Ductile iron conforming to ASTM A 536, Grade 65-45-12, rust inhibiting paint.
- C. Fittings:
1. Ductile iron conforming to ASTM A 536, Grade 65-45-12.
 2. Elbows long radius type.
- D. Bolts and Nuts: Zinc electroplated track head bolts conforming to ASTM A 183.
- E. Gasket:
1. Grade E EPDM.
 2. Temperature Range: -30 degrees F to 230 degrees F
- F. Service: Compressed air mains.

2.07 SOLDER AND BRAZING

- A. Soldered Joints:
1. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
 2. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.
 3. Service:
 - a. Above grade copper piping 2-inch and smaller
- B. Brazed Joints:
1. Wrought Copper Piping Fittings: Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.
 2. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
 3. Service :
 - a. Below grade copper piping.
 - b. Above grade copper piping larger than 2-inch.
 - c. Copper pipe, clean service.

2.08 FLEXIBLE CONNECTOR

- A. Expansion Joint/Seismic Connector:
1. T304 stainless steel hose and braid, Schedule 40 radius elbows and 180° bend, flange or weld end Schedule 40 fittings. ASA certified when used for natural gas service. Metraflex Metaloop only.
 2. Accept differential support displacement without damaging pipe, equipment connections, or support connections.
 3. In steel piping systems, three Victaulic flexible couplings may be used in lieu of a flexible connector for vibration attenuation and stress relief at equipment connections. Place couplings in close proximity to the vibration source.
- B. Service:
1. Miscellaneous drains and overflows.
 2. Domestic hot and cold water piping.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

- A. Install unions in non-flanged piping connections to apparatus and adjacent to screwed control valves, traps, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.
- B. Install piping as to vent and drain. Install according to manufacturer's recommendations.
- C. Support piping independently at apparatus so that its weight not carried by the equipment.

- D. Run piping clear of tube cleaning or removal/replacement access area on heat exchangers, water heaters, etc.
- E. Dielectric Fittings:
 - 1. Provide dielectric couplings, unions, or flanges between dissimilar metals.
 - 2. Provide dielectric couplings as required to isolate cathodically protected piping and equipment.
- F. No-Hub Couplings: Install per manufacturer's instructions.
- G. PEX System:
 - 1. Installation complies with manufacturer's product data, including product technical bulletins, installation instructions, and product carton instructions for installation.
 - 2. PEX tubing passing through metal studs provided with grommets or sleeves at the penetration.
 - 3. Protect PEX tubing with sleeves where abrasion may occur.
 - 4. Use strike protectors where PEX tubing has the potential for being struck with a screw or nail.

3.02 PIPING JOINTS

- A. Pipe and fittings joined using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes. Cleaning, cutting, reaming, grooving, etc. done with proper tools and equipment. Hacksaw pipe cutting prohibited. Peening of welds to stop leaks not permitted.
- B. Copper Piping:
 - 1. Pipe cut evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished.
 - 2. Joints uniformly heated, and capillary space completely filled with solder or braze material, leaving full bead around entire circumference.
- C. No couplings installed in floor or wall sleeves.
- D. Above Grade No-Hub Couplings: Install in accordance with manufacturer recommendations.

3.03 INSTALLATION, PIPE WRAP

- A. Apply per manufacturer's written instructions.
- B. Apply wrapping to fittings in field after installation.

3.04 ADJUSTING AND CLEANING

- A. General:
 - 1. Clean interior of piping before installation.
 - 2. Flush sediment out of piping systems after installation before connecting plumbing fixtures to the piping.
 - 3. When placing the water systems in service during construction, each system cleaned in accordance with Section 22 25 00, Plumbing Water Treatment prior to being placed in service.
 - 4. Clean strainers prior to placing in service.

END OF SECTION 22 2113

**SECTION 22 2500
PLUMBING WATER TREATMENT**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Plumbing Water Treatment

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 22, Plumbing

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Shop Drawings
 - 2. Product Data
 - 3. Operating and Maintenance Data
 - 4. Certificate of Completion
 - 5. Treatment Reports

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. US Water Services
- B. Nalco
- C. Mogul
- D. Chemax
- E. Chemcoa
- F. DuBois Chemicals
- G. Water Solutions Northwest
- H. Or approved equal.

2.02 PLUMBING WATER TREATMENT

- A. Domestic Water Chlorination:
 - 1. Chlorination accomplished by personnel in employed of firm licensed to do this type of work.
 - 2. Potable water systems disinfected prior to use as outlined within the current state or local Plumbing Code or as prescribed by the Health Authority, whichever requirements are more stringent.
 - 3. Chemicals: Sodium Hypochlorite 12.5 percent EPA registered for drinking water application.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Plumbing Domestic Water Systems:
 - 1. Provide 1/2-inch injection point on incoming water line immediately after the backflow device.
 - 2. Flush system with fresh water to remove dirt and construction debris.
 - 3. Open all fixtures to develop slow rate of flow through system.
 - 4. Injection Sodium Hypochlorite solution at a rate to achieve greater at 100ppm chlorine at fixtures.
 - 5. Flush entire system so no chlorine is present.

6. Submit bacteriological samples to certified laboratory to certify that the water is suitable for drinking. Deliver certificate stating purity of water to the Architect.

3.02 FINAL ADJUSTMENT

- A. When the systems are accepted by the Owner the chemical treatment supplier makes final adjustments in the required concentrations.
- B. Submit report of indicating initials and final concentrations and system chemistry.

END OF SECTION 22 2500

**SECTION 22 4000
PLUMBING FIXTURES**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Fixture Trim
 - 2. Plumbing Fixtures
 - 3. Drainage Products

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 22, Plumbing

1.03 QUALITY ASSURANCE

- A. Water Closets: Maximum Performance (MaP) score of no less than 800
- B. Faucets: Certify to NSF/ANSI 61 and California AB1953
- C. Electric Water Coolers and Drinking Fountains: Certified to NSF/ANSI 61 and California AB1953

1.04 SUBMITTALS

- A. Submit the following:
 - 1. Product data for each item specified.
 - 2. Operating and Maintenance Data:
 - a. Electric Water Coolers
 - b. Sensor Operated Faucets
 - c. Sensor Operated Flush Valves.
 - 3. Mounting heights for fixtures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers are stated for each fixture specified. The following manufacturers are also acceptable, except when indicated only.
- B. Fixture Trim:
 - 1. Supply Stops:
 - a. Chicago
 - b. NPT McGuire (LK series)
 - c. Brasscraft (SCR series)
 - 2. Traps:
 - a. McGuire
 - b. Kenney
 - c. Brasscraft
 - 3. Support Rims:
 - a. Hudee
 - 4. Vacuum Breakers:
 - a. Chicago Faucet
 - b. A.W. Cash
 - c. Febco, chrome plated
- C. Drainage Products and Carrier Products:
 - 1. J.R. Smith

2. Josam
 3. Sioux Chief
 4. Zurn
 5. Wade
 6. Watts Drainage
 7. Woodford
 8. Mifab
- D. Fixtures:
1. American Standard
 2. Kohler
 3. Sloan
 4. Toto
- E. Seats:
1. Olsonite
 2. Church
 3. Beneke
 4. Bemis
- F. Electric Water Coolers:
1. Elkay
 2. Halsey Taylor
 3. Oasis
 4. Sunroc
 5. Haws
- G. Stainless Steel Products:
1. Elkay
 2. Just
 3. Franke
- H. Faucets:
1. Chicago
 2. Delta Commercial
 3. Kohler
 4. Symmons
 5. Moen Commercial
- I. Shock Arrestors:
1. PPP
 2. J.R. Smith
- J. Trap Primer Stations:
1. PPP
- K. Exposed Waste and Supply Piping Insulation Kits:
1. Truebro
 2. McGuire
- L. Other Manufacturers: Submit substitution request.

2.02 FIXTURE TRIM

- A. Supply Stops: Chicago cast brass rigid riser supplies with loose key angle stops, wall flanges, NPT female inlet, chrome plate finish; equivalent NPT McGuire (LK series), Brasscraft (SCR series), or NPT stops by fixture supplier.
- B. Traps:
1. For floor drains, provide coated cast iron P-trap; recessed, screw jointed or bell and spigot.

2. For other fixtures, provide 17-gauge, chrome plated cast brass P-Traps with solder bushings, and clean-out.
- C. Support Rims: Hudee stainless steel rims, if sink not furnished with integral rim.
- D. Vacuum Breakers:
1. Chicago Faucet
 2. A.W. Cash
 3. Febco, chrome plated

2.03 PLUMBING FIXTURES

- A. WC-1 Water Closet (ADA):
1. Kohler Cimarron, vitreous china, floor mounted, elongated bowl, 16-1/2 inches floor to rim, two-piece tank type, 12-inch rough-in, white color finish. (1.28 GPF)
 2. Bemis 1600 series white open-front seat, less cover with external check hinge including 300 series stainless steel post and pintles to stop seat at 11 degrees beyond vertical.
- B. WC-2 Water Closet - Childs (ADA):
1. American Standard Baby Devero Flowise, vitreous china, floor mounted, elongated bowl, 10-1/4" from floor to rim, 10" roughin, two-piece tank type, white color finish. (1.28 GPF)
 2. Baby Devero Seat open front, less cover.
- C. L-1 Lavatory (Commercial - ADA):
1. American Standard Lucerne 20-1/2-inch by 18-1/4-inch, vitreous china, self-draining deck, backsplash, 4-inch centers, wall hung, concealed arm support, grid drain, white color finish.
 2. Chicago 802 series faucet with polished chrome plated solid brass body construction, 4-inch spout, 2-3/8 curved dual lever handles, 1/2 GPM pressure compensating aerator, quarter turn renewable compression cartridge, vandal resistant complete.
 3. J.R. Smith Series 700-Z concealed arm, floor mounted carrier or Smith series 800 wall plate.
- D. S-1 & 2 Sink:
1. Elkay LR Series, 22-inch by 19-inch by 7-1/2-inch single compartment 18-gauge, 3-hole, self-rimming, type 304 stainless steel sink, [nickel plated brass grid strainer] [chrome plated brass basket strainer].
 2. Chicago 2300 Series faucet with polished chrome plated solid brass body construction, single lever mixing valve, 10-inch cast brass spout, high temperature limit stop, 8-inch trim plate, 1.5 GPM pressure compensating laminar flow outlet, vandal resistant complete.
- E. S-4 Sink:
1. Elkay BLR Series, 15-inch by 15-inch by 7-1/2-inch single compartment 18-gauge, 3-hole, self-rimming, type 304 stainless steel sink, [nickel plated brass grid strainer] [chrome plated brass basket strainer].
 2. Chicago 2300 series faucet with polished chrome plated solid brass body construction, single lever mixing valve, 10-inch cast brass spout, high temperature limit stop, 8-inch trim plate, 1.5 GPM pressure compensating laminar flow outlet, vandal resistant complete.
- F. S-3 Sink:
1. Elkay LR Series, 33-inch by 21-inch by 7-1/2-inch double compartment 18-gauge, 4-hole, self-rimming, type 304 stainless steel sink, each compartment 14-inch by 14-inch by 7-1/2-inch deep, two chrome plated brass basket strainer.
 2. Chicago 200 Series faucet with polished chrome plated solid brass body construction, L9 swing spout, hand spray and indexed lever handles, 1.5 GPM pressure compensating laminar flow outlet, vandal resistant complete.
- G. EWC-2 Electric Water Cooler (ADA):
1. Elkay EZH20 Series dual height water cooler with bottle filling station. Stainless steel construction, satin finish.

- a. Recessed mounted
- b. SwirlFlo basins
- c. Push pad operated bubblers
- d. Anti-microbial bubbler guards
- e. Bottle Filler:
 - 1) Sensor activated
 - 2) 20 second automatic shut-off
 - 3) GPM
- f. Water Chiller:
 - 1) 8 GPH, 50-degree F water at 90-degree F ambient and 80-degree F inlet water temperature.
 - 2) 120V, single phase, 5 FLA
- g. 3000-gallon water filter
- h. Option: Front Access Panel for access to bottle filler electrical.

2.04 DRAINAGE PRODUCTS

- A. FD-1 Floor Drain: J.R. Smith 2005 Series, round nickel bronze vandal resistant grate, cast iron body with flashing collar and adjustable strainer head and no-hub outlet.
- B. WCO Wall Cleanout: J.R. Smith 4530 Series, round stainless-steel vandal resistant cover and screw.
- C. DSB-1 Downspout Boot: J.R. Smith 1787 Series, 4-inch round downspout connection.
- D. DSB-2 Downspout Boot: J.R. Smith 1785 Series, 4-inch by 3-inch rectangular downspout connection.
- E. Trap Priming Valves:
 - 1. Precision Plumbing Products Prime-time electronic trap priming manifold including but not limited to: atmospheric vacuum breaker, pre-set 24-hour clock, manual over ride, 120V slow closing solenoid valve, calibrated manifold for equal water distribution.
 - 2. Components pre-installed in recessed steel cabinet with SS access door.
- F. Water Hammer Arrester: Precision Plumbing Products Model SC (Maintenance-Free).

PART 3 EXECUTION

3.01 FIXTURE TRIM

- A. Provide plumbing fixture trim where applicable on fixtures, including but not limited to supply stops, traps, support rims, flush valve, and vacuum breakers.
- B. Provide rough-in and final piping connection to fixtures. Carefully review all construction documents to assure that all fixtures are provided with necessary services for a complete operating system.
- C. Rigidly secure rough-in piping, carriers and supports, and other service piping to structure.

3.02 PLUMBING FIXTURES

- A. Americans with Disabilities Act:
 - 1. Those fixtures indicated by ADA complies with and be installed in accordance with Americans with Disabilities Act Guidelines (ADAAG). Where applicable building code requirements are more stringent than ADAAG guidelines, building code requirements followed.
 - 2. Water Closets:
 - a. Mounting height of ADA water closet 17-inches to 19-inches from floor to top of the toilet seat.
 - b. Mount flush valve for ADA water closets on wide side of enclosure.
 - 3. Lavatories:
 - a. Mounting height of ADA lavatories at a maximum height of 34 inches from floor to rim.

- b. Provide insulation kits on exposed hot water and waste piping beneath ADA lavatories.
- 4. Sinks: Provide insulation kits on exposed hot water and waste piping beneath ADA sinks.
- 5. Urinals: Mounting height of ADA water closet at a maximum height of 17-inches from floor to top rim.
- B. Fixture Mounting Heights: Fixtures standard rough-in catalogued heights unless shown otherwise on the Architectural Drawings.
- C. Water Supplies: When both hot and cold water to a fixture is required, connect the hot on the left and the cold on the right.
- D. Floor Mounted Supports and Chair Carriers:
 - 1. Secure floor mounted supports and chair carriers to slab with a minimum of 1/2-inch bolts.
 - 2. Install supports and carriers per manufacturer's installation instructions.
- E. Lavatories, Urinals and Water Closets with Hard-Wired Electronic Sensors:
 - 1. Install sensors, wiring and piping as recommended by manufacturer.
 - 2. Provide vandalproof screws on wiring boxes for lavatories and sensor boxes.
 - 3. Mount lavatory wiring box on bottom of countertop for total concealment. Coordinate with Division 26 for plug-in transformer and receptacle locations.
 - 4. Provide one 24V transformer for any combination of 10 water closets or urinals installed side by side, and one transformer for every 6 lavatories installed side by side.
- F. Lavatories:
 - 1. Public Toilet Room: Grid strainers.
 - 2. Private Toilet Room: Pop-up waste assemblies.
 - 3. Those lavatories indicated as ADA are ADA compatible. Coordinate with Architect to verify if all wall hung lavatories are to be installed at ADA height.
- G. Floor Drain and Floor Sinks:
 - 1. Set top flush with finished floor.
 - 2. Provide flashing clamp for all drain bodies installed in floors provided with waterproof membranes.
- H. Cleanout:
 - 1. Where shown or required.
 - 2. Cover set flush with finished surface.
- I. Water Hammer Arresters: Provide where shown and where recommended by Plumbing Drainage Institute (PDI).
- J. Water Coolers and Drinking Fountains:
 - 1. Water-bearing materials comply with the Safe Drinking Water Act of 1986 and the Lead Contamination Control Act of 1988. The waterway system of the unit manufactured of copper components and other completely lead-free materials.
 - 2. Water cooler refrigerants will be non-CFC.
 - 3. Provide fixture manufacturer's wall mounting plate or floor mounted support for all wall-hung water coolers or drinking fountains.

3.03 PRIMING VALVES

- A. All floor drains, floor sinks, and similar traps primed. Use minimum 3/8-inch type K annealed copper tubing. Primer line to be continuous and without joints.
- B. Where priming valves are installed in finished rooms, conceal in wall and provide access panel.
- C. Coordinate locations of electronic trap primer stations with electrical contractor for 120V service.

END OF SECTION 22 4000

**SECTION 23 0500
COMMON WORK RESULTS FOR HVAC**

PART 1 GENERAL

1.01 SUMMARY

- A. The intent of this Division's Specifications and Drawings is to provide a complete and workable facility, with complete systems as required by applicable codes, as indicated, and as specified.
- B. Provide a complete and workable facility with complete systems that comply with the requirements of the state codes, local codes, and other authorities having jurisdiction. Include design, labor and materials required to install, test and place into operation the systems as called for in the Contract Documents and according to applicable codes and regulations.
- C. Specifications and the accompanying Drawings are complementary and what is called for by one is as binding as if called for by both.
- D. The General and Supplemental Conditions apply to this Division, including but not limited to:
 - 1. Drawings and Specifications.
 - 2. Public ordinances and permits.
 - 3. Payments and fees required by governing authorities for work of this Division.
- E. The Drawings that accompany this Division are diagrammatic. They do not show every offset, bend, or elbow, which may be required to install work in the space provided and avoid conflicts with other construction.
- F. Provide all connections, raceway, wiring, breakers and installation required for systems specified, as required by the manufacturers installation documents, and for complete system functionality.
- G. Offsets and transitions are to be assumed at a minimum at each crossing of services, structural penetrations through shear walls or beams, structural grids, where ceiling heights are restricted, and at piping and conduit mains.
- H. Follow the Drawings as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions, and without additional cost to the Owner. Significant deviations from the routing shown on the drawings is subject for approval prior to installation. The right is reserved by the design team to make reasonable changes in locations of system components prior to roughing-in, without cost impact.
- I. Verify dimensions, field conditions, quantities, and measurements prior to installing work.
- J. Work done under this Division of the specifications includes the furnishing of labor, material, equipment, and tools required for the complete installation of the work indicated on the Drawings or as specified herein.
- K. Work installed contrary to Drawings and Specifications is subject to change as directed by the Owner and no extra compensation will be allowed for making those changes.

1.02 PRICE AND PAYMENT PROCEDURES

- A. Allowances
 - 1. Comply with Division 01, General Requirements.
- B. Alternates
 - 1. Comply with Division 01, General Requirements.
 - 2. Refer to Drawings for detailed information relating to the appropriate alternates.

1.03 RELATED REQUIREMENTS

- A. Division 00, Procurement and Contracting Requirements
- B. Division 01, General Requirements
- C. Section 23 0513 - Common Motor Requirements for HVAC Equipment
- D. Section 23 0523 - General-Duty Valves for HVAC Piping

- E. Section 23 0529 - Hangers and Supports for HVAC Piping and Equipment
- F. Section 23 0553 - Identification for HVAC Piping and Equipment
- G. Section 23 0590 - Pressure Testing for HVAC Systems
- H. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC
- I. Section 23 0713 - Duct Insulation
- J. Section 23 0716 - HVAC Equipment Insulation
- K. Section 23 0719 - HVAC Piping Insulation
- L. Section 23 0913 - Instrumentation and Control Devices for HVAC
- M. Section 23 0923 - Direct-Digital Control System for HVAC
- N. Section 23 2113 - Hydronic Piping
- O. Section 23 2114 - Hydronic Specialties
- P. Section 23 2123 - Hydronic Pumps
- Q. Section 23 2500 - HVAC Water Treatment
- R. Section 23 3100 - HVAC Ducts and Casings
- S. Section 23 3300 - Air Duct Accessories
- T. Section 23 3700 - Air Outlets and Inlets
- U. Section 23 4000 - HVAC Air Cleaning Devices
- V. Section 23 7223 - Packaged Air-to-Air Energy Recovery Units
- W. Section 23 8126.13 - Small-Capacity Split-System Air Conditioners
- X. Section 23 8129 - Variable Refrigerant Flow HVAC Systems
- Y. Section 23 8216 - Air Coils

1.04 REFERENCE STANDARDS

- A. Refer to individual sections under this Division for applicable reference standards.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
 - 1. Review Drawings of other trades and Owner provided equipment to avoid conflicts.
 - 2. Report potential conflicts to Architect, prior to rough-in.
 - 3. Architectural Drawings take precedence regarding exact placement of system components and equipment.
 - 4. Verify the physical dimensions of equipment to fit the space available.
 - 5. Coordinate access routes through the construction, equipment move-in planning, and provide all required equipment, transport and services necessary to facilitate installation of equipment.
 - 6. Where connections are required for equipment provided as Work of other Divisions, coordinate rough in and connection requirements for that equipment with its supplier and installer prior to commencing work.
 - 7. Notify Architect of any discrepancies between the actual rough in and connection requirements, and those identified on Drawings for resolution prior to installation.
 - 8. Coordinate underground work with other trades working on the site.
 - a. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained.
 - 9. Coordinate installation of required supporting devices and set sleeves in architectural and structural components as they are constructed.
 - 10. Coordinate location of access panels and doors for items concealed behind finished surfaces with Architect.
 - 11. Coordinate sleeve selection and application with firestopping specified elsewhere.
 - 12. Finishes: Coordinate with Architect, finish to match surrounding surfaces.
- B. Permits

1. Obtain permits and inspections for the installation of work and pay charges required. Deliver certificates of inspection issued by authorities to the Owner.

1.06 SUBMITTALS

- A. General Submittal Requirements:
 1. Refer to Division 00 and Division 01 for general submittal requirements.
 2. Requirements set forth in this Section pertain to all specifications included in this Division of work.
- B. Pre-Bid Submittal Requirements
 1. Submit Questions and Substitution Requests before the Questions deadline, defined in Division 00 and Division 01.
- C. Bid Submittal Requirements
 1. Refer to individual Division sections for specific requirements due with Bid.
- D. Contractor Responsibilities:
 1. Provide submittals one time and organized in proper order.
 2. Indicate deviations from Drawings and Specifications explicitly in the submittals. Failure to comply will void review automatically.
- E. Submittal Schedule:
 1. General:
 - a. Submit a schedule that is coordinated with the project construction schedule.
 - b. Allow for time required for review of submittals, making corrections/revisions to submittals, ordering, manufacturing, fabrication, and delivery.
 2. Submittal Schedule to include the following for each submittal as a minimum:
 - a. Identify submittal by specification section number and title.
 - b. Date the item will be submitted. Arrange items in chronological order by scheduled date for first submittal.
 - c. Identify critical submittals and long lead items explicitly.
 - d. Submittal Category:
 - 1) Product Data
 - 2) Coordination Drawings
 - 3) Shop Drawings
 - 4) Samples
 - 5) Certificates
 - 6) Delegated Design Submittals
 - 7) Test and Evaluation Reports
 - 8) Manufacturers' Instructions
 - 9) Source Quality Control
 - 10) Site Quality Control
 - 11) Manufacturer Reports
 - 12) Sustainable Design
 - 13) Qualification Statements
 - e. Closeout Submittal Category:
 - 1) Maintenance Contracts
 - 2) Operations and Maintenance Data
 - 3) Bonds
 - 4) Warranty Documentation
 - 5) Final Test and Evaluation Reports
 - 6) Record Documentation
 - 7) Demonstration and Training
 - 8) Sustainable Design Closeout

9) Software

F. Product Data:

1. General:

- a. Assemble complete submittal package for this Division into a single submittal.
 - 1) Partial submittals will not be accepted.
- b. Submit product data on following equipment for review:
 - 1) Equipment scheduled on Drawings.
 - 2) Equipment requiring electrical connections or connections by other trades.
 - 3) As required by each specification section or by notes on the Drawings.

2. Format:

- a. Electronic: Submit electronic copies for Work of this Division in PDF format.
 - 1) Include a complete index in the original submittal.
 - (a) Incorporate links enabling navigation to each item.
 - (b) Identify with each item filed under a folder and labeled with its respective specification section number, Article, and paragraph.
 - 2) Provide cover sheet for each applicable section number.

3. Include for each item as a minimum:

- a. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified.
- b. Manufacturer's detailed shop drawings including clearances required.
- c. Manufacturer's detailed specifications.
- d. Manufacturer's data sheets including capacities, operating speeds, power requirements, design and operating conditions, performance curves, characteristics scheduled or described on the Drawings, and similar data.
- e. List the name of the motor manufacturer and service factor for each piece of equipment.
- f. Indicate equipment operating weights including bases and weight distribution at support points.
- g. Wiring diagrams showing factory installed wiring.

G. Coordination Drawings:

1. General:

- a. Assemble complete submittal package for the project into a minimum of two submittals.
 - 1) Coordination Drawings - Below Grade
 - 2) Coordination Drawings - Above Grade
- b. Prepare project-specific information, drawn accurately to scale.
- c. Submit coordination drawings for review prior to beginning fabrication.
- d. Sheet Size: Match sheet size of Construction Drawings.
- e. Prepare in three-dimensional format utilizing the same digital data software program, version, and operating system utilized to develop the Construction Drawings.

2. Format:

- a. Electronic: Submit electronic copies in PDF format.

3. Include as a minimum:

- a. Color code and overlay shop drawings for each trade:
 - 1) Structural
 - 2) Civil
 - 3) Ceiling Systems
 - 4) HVAC Equipment
 - 5) HVAC Ductwork
 - 6) HVAC Piping
 - 7) Plumbing Equipment

- 8) Plumbing Piping
 - 9) Fire Suppression
 - 10) Lighting
 - 11) Electrical Power
 - 12) Communications
 - 13) Electronic Safety and Security
 - b. Complete floor plans to a minimum of 1/4-inch equals 1-foot scale.
 - c. Mechanical rooms to a minimum of 1/2-inch equals 1-foot scale.
 - d. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
- H. Shop Drawings:
- 1. General:
 - a. Assemble complete submittal package for this Division into a single submittal.
 - 1) Partial submittals will not be accepted.
 - b. Prepare project-specific information, drawn accurately to scale.
 - c. Prepare new Shop Drawings by Contractor and not reproductions or tracings of Engineer's Design Drawings.
 - d. Submit shop drawings for review prior to beginning fabrication.
 - 1) Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.
 - e. Sheet Size: Match sheet size of Construction Drawings.
 - f. Prepare in three-dimensional format utilizing the same digital data software program, version, and operating system utilized to develop the Construction Drawings.
 - 2. Format:
 - a. Electronic: Submit electronic copies for Work of this Division in PDF format.
 - 1) Include a complete index in the original submittal.
 - (a) Incorporate links enabling navigation to each item.
 - (b) Identify with each item filed under a folder and labeled with its respective specification section number, Article and paragraph.
 - 3. Include as a minimum:
 - a. Complete floor plans to a minimum of 1/4-inch equals 1-foot scale.
 - b. Mechanical, Electrical, and Technology rooms to a minimum of 1/2-inch equals 1-foot scale.
 - c. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
 - d. Fabricated equipment to a minimum of 1/4-inch equals 1-foot scale.
- I. Samples
- 1. Refer to individual Division sections for Submittal requirements.
- J. Certificates
- 1. Refer to individual Division sections for Submittal requirements.
- K. Delegated Design Submittals
- 1. Refer to individual Division sections for Submittal requirements.
- L. Test and Evaluation Reports
- 1. Refer to individual Division sections for Submittal requirements.
- M. Manufacturers' Instructions
- 1. Refer to individual Division sections for Submittal requirements.
- N. Source Quality Control Submittals
- 1. Refer to individual Division sections for Submittal requirements.
- O. Site Quality Control Submittals
- 1. Refer to individual Division sections for Submittal requirements.
- P. Manufacturer Reports

- 1. Refer to individual Division sections for Submittal requirements.
- Q. Sustainable Design Submittals
 - 1. Refer to individual Division sections for Submittal requirements.
- R. Qualification Statements
 - 1. Refer to individual Division sections for Submittal requirements.

1.07 CLOSEOUT SUBMITTALS

- A. Maintenance Contracts
 - 1. Refer to individual Division sections for Submittal requirements.
- B. Operations and Maintenance Data
 - 1. General:
 - a. Assemble complete submittal package for this Division into a single submittal.
 - 1) Partial submittals will not be accepted.
 - b. Submit when the work is substantially complete.
 - c. Submit manufacturer's operation and maintenance instruction manuals and parts lists for review on following equipment:
 - 1) Equipment scheduled on Drawings.
 - 2) Equipment requiring electrical connections or connections by other trades.
 - 3) As required by each specification section or by notes on the Drawings.
 - 2. Format:
 - a. Electronic: Submit electronic copies for Work of this Division in PDF format.
 - 1) Include a complete index in the original submittal.
 - (a) Incorporate links enabling navigation to each item.
 - (b) Identify with each item filed under a folder and labeled with its respective specification section number, Article and paragraph.
 - 3. Include for each item as a minimum:
 - a. Include name and contact information for location of source parts and service for each piece of equipment.
 - b. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified.
 - c. Manufacturer's operation and maintenance instruction manuals.
 - d. Manufacturer's detailed shop drawings including clearances required.
 - e. Manufacturer's detailed specifications.
 - f. Manufacturer's data sheets including capacities, operating speeds, power requirements, design and operating conditions, performance curves, characteristics scheduled or described on the Drawings, and similar data.
 - g. List the name of the motor manufacturer and service factor for each piece of equipment.
 - h. Indicate equipment operating weights including bases and weight distribution at support points.
 - i. Wiring diagrams showing factory installed wiring.
- C. Bonds
 - 1. Refer to individual Division 00 and Division 01 sections for Submittal requirements.
- D. Warranty Documentation
 - 1. Refer to individual Division 00 and Division 01 sections for Submittal requirements.
- E. Final Test and Evaluation Reports
 - 1. Refer to individual Division sections for Submittal requirements.
- F. Record Documentation
 - 1. Shop Drawings

- a. Shop drawings updated with as-built information and submitted as the record drawing set.
- 2. Record Drawings
 - a. General:
 - 1) Provide drawings with notations reflecting the as-built conditions.
 - 2) Notations to include any additions to or variations from the construction documents provided as part of the BIM coordination, RFIs, ASIs, Owner Changes, and Field Coordination.
 - 3) Prepare project-specific information, drawn accurately to scale.
 - 4) Provide project specific title block.
 - b. Sheet Size: Match sheet size of Construction Drawings.
 - c. Prepare in two-dimensional format utilizing the same digital data software program, version, and operating system utilized to develop the Construction Drawings.
 - d. Format:
 - 1) Electronic: Submit electronic copies of record drawings for Work of this Division in PDF format.
 - (a) Include a complete index in the original submittal.
 - (b) Incorporate links enabling navigation to each item.
 - (c) Identify with each item filed under a folder and labeled with its respective specification section number, Article and paragraph.
- G. Demonstration and Training
 - 1. Training Plan:
 - a. Submit outline of instructional program for demonstration and training.
 - b. Include the following:
 - 1) List of training modules.
 - 2) Schedule of proposed dates, times, length of instruction time.
 - 3) Instructors' names for each training module.
 - 4) Learning objective and outline for each training module.
 - 2. Training Video Recordings:
 - a. Identification: On each copy, provide an applied label with the following information:
 - 1) Name of Project.
 - 2) Name and address of videographer.
 - 3) Name of Architect.
 - 4) Name of Contractor or Construction Manager.
- H. Sustainable Design Closeout Documentation
 - 1. Refer to individual Division sections for Submittal requirements.
- I. Software
 - 1. Refer to individual Division sections for Submittal requirements.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts
 - 1. Refer to individual Division sections for Submittal requirements.
- B. Extra Stock Materials
 - 1. Refer to individual Division sections for Submittal requirements.
- C. Tools
 - 1. Refer to individual Division sections for Submittal requirements.

1.09 QUALITY ASSURANCE

- A. Regulatory Requirements

1. Products and equipment are prohibited from containing pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
2. General:
 - a. Conform Work and materials to requirements of the local, State, and Federal authorities having jurisdiction and other applicable laws and regulations.
 - b. Where codes or standards are referenced, the applicable portions apply.
 - c. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, apply the more stringent.
 - d. Should any change in drawings or specifications be required to comply with governing regulations, notify the Architect prior to submitting bid.
 - e. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, skillful and well-executed manner by competent workers. Provide a competent, experienced full-time Superintendent who is authorized to make decisions on behalf of the Contractor.
 - f. The Architect or Architect's Representative may conduct unannounced field reviews of any work completed or in progress during the Contractor's working hours. A report will be issued to the Contractor if the field review of the systems construction has revealed elements of the work which are inconsistent with the Contract Documents. All items in the report are to be addressed in writing by the Contractor within 2 weeks and corrections in the field made as directed.
- B. Apparatus:
 1. Build and install to deliver full rated capacity at the efficiency for which it was designed.
 2. Provide entire system and apparatus that operate at full capacity without objectionable noise or vibration.
- C. Install equipment level and true. Provide housekeeping pads and curbs accounting for floor or roof slope.
- D. Materials and Equipment:
 1. Provide new work of good quality, free of faults and defects and in conformance with the Construction documents.
 2. Each piece of equipment furnished will meet the detailed requirements of the Drawings and Specifications and will be suitable for the installation shown. Equipment not meeting the requirements will not be acceptable, even though specified by name along with other manufacturers.
 3. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
 4. Furnish materials and equipment of size, make, type, and quality herein specified.
 5. Equipment scheduled by performance or model number is considered as the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the Contractor is responsible for changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements, or any other differences which impact the project.
- E. Workmanship:
 1. General: Install materials in a neat and professional manner.
 2. Manufacturer's Instructions:

- a. Follow manufacturer's directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division Specifications, obtain clarification before starting work.
- F. Cutting and Patching:
1. Provide cutting, patching, and repairing for the proper installation and completion of the work specified in this Division by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work. This work includes but is not limited to plastering, masonry work, concrete work, carpentry work, and painting.
 2. Make additional openings required in building construction by drilling or cutting. Use of jackhammer is specifically prohibited.
 3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
 4. Do not pierce beams, columns or structure members without approval from the Architect and structure engineer, and then only as directed.
 5. New or existing work cut or damaged will be restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces will be repaired, refinished, and left in condition existing prior to commencement of work.
- G. Visibly damaged goods are to be returned to the supplier and replaced at no additional cost to the Owner.
- H. Contractor Responsibility:
1. Examination of building and site responsibility:
 - a. Examine site and building prior to installation to determine conditions affecting the scope of work.
 - b. Contact Owner representative for arrangements.
 2. Respect and protect the privacy and confidentiality of Owner, its employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the State and Owner policies.
 3. Total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications.
 4. Specified systems installed under the direction of a qualified Contractor. Qualification requirements include submittal by the Contractor to the Architect of the following:
 - a. Have experience with three or more installations of systems comparable in size, complexity, type, and design as specified herein.
 - b. Perform each of these installations satisfactorily for at least one year after final acceptance by the user. Include the names, locations, and point of contact for these installations as a part of the initial submittal documentation.
 - c. List of previous projects of this scope, size, and nature, including names and sizes of projects, description of work, time of completion, and names of contact persons for reference.
- I. Manufacturers
1. Equipment in these Sections are the standard products of a manufacturer regularly engaged in the manufacture of such products unless specified otherwise. Provide commercial grade components and products used in the system that comply with these Specifications.
 2. Each component of equipment identifies the manufacturer's name, model, and applicable serial number. The Owner's authorized representative retains the right to reject products that reflect, in their opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.
- J. Certifications
1. Refer to individual Division sections for Submittal requirements.

- K. Sustainability Standards Certifications
 - 1. Refer to individual Division sections for Submittal requirements.
- L. Preconstruction Testing
 - 1. Refer to individual Division sections for Submittal requirements.
- M. Site Samples
 - 1. Refer to individual Division sections for Submittal requirements.
- N. Mock-ups
 - 1. Refer to individual Division sections for Submittal requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Assume custody and responsibility for the items upon delivery and determining that the contents are complete and in satisfactory condition for installation.
- B. The Contractor is responsible for handling and control of equipment and liable for material loss due to delivery and storage problems.
- C. Materials and equipment delivered and placed in storage will be stored with protection from the weather, humidity, and temperature variation, dirt, and dust or other contaminants.
- D. Coordinate deliveries and submittals with the General Contractor/Owner to ensure a timely scheduled installation.
- E. Equipment and materials are to be delivered to the site no more than three weeks prior to the commencement of its installation. Coordinate with General Contractor/Owner for the location of storage materials.

1.11 SITE CONDITIONS

- A. Existing Conditions:
 - 1. Prior to bidding, verify and become familiar with existing conditions by visiting the site.
 - 2. Include related costs associated with site factors in the initial bid proposal.
- B. Coordinate exact requirements governed by actual job conditions. Check information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.
- C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City, and Utility Company.

1.12 WARRANTY

- A. Provide a written guarantee covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.
- B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.
- C. Correct warranty items promptly upon notification.
- D. Apparatus:
 - 1. Free of defects of material and workmanship and in accord with the Contract Documents.
 - 2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.

1.13 DEMOLITION AND SALVAGE

- A. General:
 - 1. Where affected by work, remove or relocate equipment, services, and systems encountered during the course of the remodel/construction work to a safe location that will be undisrupted by further construction.
- B. Salvage and Disposal:
 - 1. Removed materials, not containing hazardous waste, not scheduled for reuse are the property of the Contractor for removal from the site, except for those items specifically indicated on the Drawings for salvage or reuse.

2. Identify materials containing, or possibly containing, hazardous waste for removal and disposal by the Hazardous Waste Contractor.
3. Neatly store salvaged items at one location at the site where directed by the Owner's Representative.

PART 2 PRODUCTS

2.01 MACHINERY GUARDS

- A. Furnish guards for protection on rotating and moving parts of equipment. Provide guards for metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.
- B. Design guards so as not to restrict air flow at fan inlets resulting in reduced capacity.
- C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards easily removable for pulley adjustment or removal and changing of belts.
- D. Guards meet OSHA requirements including back plates.
- E. Provide inlet and outlet screens on fans in plenums or where exposed to personnel.

2.02 ELECTRICAL EQUIPMENT

- A. General: Equipment and installed work as specified under Division 26, Electrical.
- B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available fault current rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment with a Short Circuit Current Rating (SCCR) that meets the bracing requirement.
- C. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.
- D. Equipment Wiring:
 1. Interconnecting wiring within or on a piece of mechanical equipment provided with the equipment unless shown otherwise.
 2. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.
- E. Control Wiring: Control wiring for mechanical equipment provided under Section 23 0913 - Instrumentation and Control Devices for HVAC.
- F. Codes: Electrical equipment and products bear the UL label as required by governing codes and ordinances.

PART 3 EXECUTION

3.01 ACCESSIBILITY

- A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.
- B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms, and walkways.

3.02 ACCESS PANELS

- A. Install in accord with manufacturer's recommendations, coordinated with architectural features.
- B. Provide 2-hour fire rated doors where required bearing the UL label.
- C. Furnish 24-inch by 24-inch panels for ceilings and for access to equipment in soffits and shafts, and 12-inch by 12-inch for walls unless indicated otherwise.
- D. Furnish where indicated and where required to access valves, fire/smoke dampers, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.03 ELECTRICAL EQUIPMENT

- A. Ductwork or piping for mechanical systems not serving electrical space not installed in any switchgear room, transformer vault, telephone room, or electric closet except as indicated.
- B. Ductwork or piping for mechanical systems not to pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.04 EQUIPMENT CONNECTIONS

- A. Make final connections to equipment specified in sections other than Division 23, HVAC of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.
- B. Piping:
 - 1. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
 - 2. Independently support piping connections to prevent undue strain on equipment.
- C. Ductwork: Make exhaust connections to equipment in strict accordance with manufacturer's instructions.

3.05 PAINTING

- A. General:
 - 1. Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting.
 - 2. Exposed work under this Division receives either a factory painted finish or a field prime coat finish, except:
 - a. Exposed copper piping.
 - b. Aluminum jacketed outdoor insulated piping.
- B. Equipment Rooms and Finished Areas:
 - 1. Insulation: Not painted.
 - 2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
 - 3. Steel Valve Bodies and Bonnets: One coat of black enamel.
 - 4. Brass Valve Bodies: Not painted.
 - 5. Equipment:
 - a. One coat of grey machinery enamel.
 - b. Do not paint nameplates.
 - 6. Grilles, Diffusers, Registers: Paint sheet metal and visible ductwork behind grilles, diffusers, and registers flat black.
- C. Concealed Spaces (above ceilings, not visible):
 - 1. Insulation: Not painted.
 - 2. Do not paint the following:
 - a. Hangers
 - b. Uninsulated Piping
 - c. Miscellaneous Iron Work
 - d. Valve Bodies and Bonnets
- D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.
- E. Roof Mounted Equipment:
 - 1. Paint two coats of exterior machinery enamel.
 - 2. Color as selected by Architect.
 - 3. Where factory standard finish is indicated in the equipment specification, it is assumed that the standard finish is painted.

- F. Exterior Black Steel Pipe:
 - 1. Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel.
 - 2. Painting schemes comply with ANSI A13.1.

3.06 ADJUSTING

- A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.
- B. Use particular care in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.07 CLEANING

- A. General: Clean mechanical equipment, piping and ductwork of stampings and markings (except those required by codes), iron cuttings, and other refuse.
- B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.
- C. Additional requirements are specified under specific Sections of this Division.

3.08 PROTECTION

- A. Keep pipe, ductwork, and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, ductwork, equipment, and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.
- B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.
- C. Cover or otherwise suitably protect equipment and materials stored on the job site.

END OF SECTION 23 0500

**SECTION 23 0513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Single phase electric motors.
- D. Three phase electric motors.
- E. Electronically Commutated Motors (ECM).

1.02 RELATED REQUIREMENTS

- A. Section 26 0583 - Wiring Connections.
- B. Section 26 2913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
- C. NEMA MG 1 - Motors and Generators.
- D. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.
- B. Conform to NFPA 70 and local energy code.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

- A. See Section 23 0500 - Common Work Results for HVAC for additional warranty requirements.
- B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- C. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- D. Equip motors served from variable frequency drives with shaft grounding system providing a path for current to flow between the shaft and motor frame.
- E. Motors served from variable frequency drives manufactured to withstand repeated voltage peaks of 1600V with rise times of 0.1 microseconds and greater in accordance with NEMA MG 1 Part 31.

2.02 APPLICATIONS

- A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

2.03 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Starting Torque: Less than 150 percent of full load torque.
- B. Starting Current: Up to seven times full load current.
- C. Breakdown Torque: Approximately 200 percent of full load torque.
- D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.04 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Starting Torque: Exceeding one fourth of full load torque.
- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.
- D. Open Drip-proof: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.
- E. Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.05 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.06 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. General: DC motor with integral controller.
- B. Rotor: Permanent magnet type.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

- D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 2913.
- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours.
Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- J. Sound Power Levels: To NEMA MG 1.
- K. Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
- L. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- M. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.
- N. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION 23 0513

**SECTION 23 0523
GENERAL-DUTY VALVES FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Angle valves.
- B. Globe valves.
- C. Ball valves.
- D. Butterfly valves.
- E. Check valves.
- F. Gate valves.

1.02 RELATED REQUIREMENTS

- A. Section 23 0553 - Identification for HVAC Piping and Equipment.
- B. Section 23 0716 - HVAC Equipment Insulation.
- C. Section 23 0719 - HVAC Piping Insulation.
- D. Section 23 2113 - Hydronic Piping.

1.03 ABBREVIATIONS AND ACRONYMS

- 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. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. TFE: Tetrafluoroethylene.
- I. WOG: Water, oil, and gas.

1.04 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
- B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
- D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
- E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- F. ASME B16.34 - Valves — Flanged, Threaded, and Welding End.
- G. ASME B31.1 - Power Piping.
- H. ASME B31.9 - Building Services Piping.
- I. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- J. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- K. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- L. ASTM A536 - Standard Specification for Ductile Iron Castings.
- M. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
- N. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
- O. AWWA C606 - Grooved and Shouldered Joints.
- P. MSS SP-45 - Bypass and Drain Connections.

- Q. MSS SP-67 - Butterfly Valves.
- R. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
- S. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
- T. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
- U. MSS SP-85 - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends.
- V. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- W. MSS SP-125 - Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves.

1.05 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC, for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information.
 - 1. Performance ratings
 - 2. Rough-in details
 - 3. Weights
 - 4. Support requirements
 - 5. Piping connections
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed with Owner named and registered with manufacturer.
- D. Operation and Maintenance Data:
 - 1. Manufacturer's descriptive literature
 - 2. Operating instructions
 - 3. Maintenance and repair data
 - 4. Parts listings

1.06 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.
 - a. Apollo
 - b. Armstrong
 - c. Bell and Gossett
 - d. Crane
 - e. DeZurik
 - f. Hammond
 - g. Kennedy
 - h. Metraflex
 - i. Milwaukee
 - j. Mueller
 - k. Nibco
 - l. Stockham
 - m. Taco
 - n. Tour and Andersson
 - o. Walworth
 - p. Wheatley
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.

4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 5. Secure check valves in either the closed position or open position.
 6. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.
- C. Exercise the following precautions for handling:
1. Handle large valves with sling, modified to avoid damage to exposed parts.
 2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. See drawings for specific valve locations.
- B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).
- C. Provide the following valves for the applications if not indicated on drawings:
1. Isolation (Shutoff): Butterfly and Ball.
 2. Swing Check (Pump Outlet):
 - a. Size 2 inch and Smaller: Bronze with bronze disc.
 - b. 2-1/2 NPS and Larger: Iron with lever and spring, center-guided metal, or center-guided with resilient seat.
 3. Dead-End: Butterfly, single-flange (lug) type.
- D. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.
- E. Required Valve End Connections for Non-Wafer Types:
1. Steel Pipe:
 - a. Size 2 inch and Smaller: Threaded ends.
 - b. 2-1/2 NPS and Larger: Flanged ends.
 2. Copper Tube:
 - a. 2 NPS and Smaller: Soldered ends.
 - b. 2-1/2 NPS and Larger: Brazed ends.
- F. Heating Hot Water Valves:
1. 2 NPS and Smaller, Brass and Bronze Valves:
 - a. Solder-joint ends.
 - b. Angle: Bronze disc, Class 125.
 - c. Ball: Full port, one piece, brass trim.
 - d. Swing Check: Bronze disc, Class 125.
 - e. Gate: NRS, Class 125.
 - f. Globe: Bronze disc, Class 125.
 2. Size 2-1/2 inch and Larger, Iron Valves:
 - a. 2-1/2 NPS to 4 NPS: Flanged ends.
 - b. Ball: 2-1/2 inch to 10 inch, Class 150.
 - c. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
 - d. Single-Flange Butterfly: 14 inch to 24 inch, aluminum-bronze disc, EPDM seat, 150 CWP.

- e. Swing Check: Metal seats, Class 125.
- f. Swing Check: 2-1/2 inch to 12 inch, lever and spring closure control, Class 125.
- g. Center-Guided Check: Compact-wafer, metal seat, Class 125.
- h. Gate: NRS, Class 125.
- i. Globe: 2-1/2 inch to 12 inch, Class 125.

2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings:
 - 1. No less than rating indicated.
 - 2. As required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Gear Actuator: Quarter-turn valves 8 inch and larger.
 - 2. Handwheel: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 NPS and smaller.
 - 4. Chainwheel:
 - a. Device for attachment to valve handwheel, stem, or other actuator.
 - b. Refer to Part 3 Installation for applied locations and installation requirements.
- D. Valves in Insulated Piping: Provide stem extensions and the following features to allow full operation of valve without breaking insulation vapor seal or disturbing insulation:
 - 1. Gate Valves: Rising stem.
 - 2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve.
 - 3. Butterfly Valves: Extended neck.
 - 4. Memory Stops: Fully adjustable after insulation is installed.
- E. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.
 - 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 - 3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
 - 4. Solder Joint Connections: ASME B16.18.
 - 5. Grooved End Connections: AWWA C606.
- F. General ASME Compliance:
 - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 - 2. Power Piping Valves: ASME B31.1.
 - 3. Building Services Piping Valves: ASME B31.9.
- G. Bronze Valves:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- H. Valve Bypass and Drain Connections: MSS SP-45.
- I. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE, ANGLE VALVES

- A. Comply with MSS SP-80, Type 1.
- B. Class 125: CWP Rating: 200 psig.
- C. Class 150: CWP Rating: 300 psig.
- D. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
- E. Ends: Threaded or solder joint.
- F. Stem: Bronze.
- G. Disc: Bronze.
- H. Packing: Asbestos free.
- I. Operator: Handwheel or chainwheel.

2.04 BRONZE, GLOBE VALVES

- A. Comply with MSS SP-80, Type 1.
- B. Class 125: CWP Rating: 200 psig.
- C. Class 150: CWP Rating: 300 psig.
- D. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
- E. Ends: Threaded or solder joint.
- F. Stem and Disc: Bronze.
- G. Packing: Asbestos free.
- H. Operator: Handwheel or chainwheel.

2.05 IRON, GLOBE VALVES

- A. Comply with MSS SP-85, Type I.
- B. Class 125: CWP Rating: 200 psig.
- C. Class 150: CWP Rating: 300 psig.
- D. Ends: Flanged.
- E. Trim: Bronze.
- F. Packing and Gasket: Asbestos free.
- G. Operator: Handwheel or chainwheel.

2.06 BRONZE, BALL VALVES

- A. General:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Two Piece, Full Port with Bronze or Brass Trim:
 - 1. Comply with MSS SP-110.
 - 2. Class 125: CWP Rating: 200 psig.
 - 3. Class 150: CWP Rating: 600 psig.
 - 4. Ends: Threaded or soldered joint.
 - 5. Stem: Bronze or brass.
 - 6. Ball: Chrome plated brass.

2.07 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug Style; Bidirectional dead-end service without use of downstream flange:
 - 1. Comply with MSS SP-67, Type I.
 - 2. Lug Style, CWP Ratings:
 - a. Sizes 2 to 12 inch: 150 psi.
 - b. Sizes 14 to 24 inch: 100 psi.
 - c. Vacuum Service: Down to 29.9 in-Hg.
 - 3. Class 125: CWP Rating: 200 psig.
 - 4. Class 150: CWP Rating: 300 psig.
 - 5. Body Material: ASTM A536 ductile iron.
 - 6. Stem: One-piece stainless steel.
 - 7. Seat: EPDM.
 - 8. Disc: Aluminum-bronze.

2.08 BRASS, INLINE CHECK VALVES

- A. Class 150: CWP Rating: 200 psi .
- B. Maximum Service Temperature: 250 degrees F.
- C. Body: Forged brass.
- D. Disc: Forged brass.
- E. Seal: PTFE, bubble tight.

F. End-Connections: Press.

2.09 BRASS, HORIZONTAL SWING CHECK VALVES

2.10 BRONZE, SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig.
- B. Class 150: CWP Rating: 300 psig.

2.11 IRON SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig.
- B. Class 150: CWP Rating: 300 psig.
- C. Ends: Flanged.

2.12 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Comply with MSS SP-71, Type I.
- B. Class 125: CWP Rating: 200 psig.
- C. Class 150: CWP Rating: 300 psig.
- D. Body Design: Clear or full waterway.
- E. Body Material: ASTM A126, gray iron with bolted bonnet.
- F. Ends: Flanged.
- G. Trim: Bronze.
- H. Gasket: Asbestos free.
- I. Closer Control: Factory installed, exterior lever, and spring or weight.

2.13 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Compact-Wafer:
 - 1. Comply with MSS SP-125.
 - 2. Sizes 2-1/2 to 12 inch: CWP Rating; 200 psi.
 - 3. Sizes 14 to 24 inch: CWP Rating; 150 psi.
 - 4. Body Material: ASTM A126, gray iron.
 - 5. Metal Seat: Bronze.
- B. Class 125, Globe:
 - 1. Comply with MSS SP-125.
 - 2. Sizes 2-1/2 to 12 inch: CWP Rating; 200 psi.
 - 3. Sizes 14 to 24 inch: CWP Rating; 150 psi.
 - 4. Body Material: ASTM A126, gray iron.
 - 5. Style: Spring loaded.
 - 6. Ends: Flanged.
 - 7. Metal Seat: Bronze.
- C. Class 150, Compact-Wafer:
 - 1. Comply with MSS SP-125.
 - 2. Sizes 2-1/2 to 12 inch: CWP Rating; 300 psi.
 - 3. Sizes 14 to 24 inch: CWP Rating; 250 psi.
 - 4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - 5. Metal Seat: Bronze.
- D. Class 150, Globe:
 - 1. Comply with MSS SP-125.
 - 2. Sizes 2-1/2 to 12 inch: CWP Rating; 300 psi.
 - 3. Sizes 14 to 24 inch: CWP Rating; 250 psi.
 - 4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - 5. Style: Spring loaded.
 - 6. Ends: Flanged.
 - 7. Metal Seat: Bronze.

2.14 BRONZE, GATE VALVES

- A. Non-Rising Stem (NRS), Rising Stem (RS), or Outside Stem and Yoke (OSY):
 - 1. Comply with MSS SP-80, Type I.
 - 2. Class125: CWP Rating: 200 psig.
 - 3. Class 150: CWP Rating: 300 psig.
 - 4. Body Material: Bronze with integral seat and union-ring bonnet.
 - 5. Ends: Threaded.
 - 6. Stem: Bronze.
 - 7. Disc: Solid wedge; bronze.
 - 8. Packing: Asbestos free.
 - 9. Handwheel: Malleable iron, bronze, or aluminum.

2.15 IRON, GATE VALVES

- A. Non-Rising Stem (NRS), Rising Stem (RS), or Outside Stem and Yoke (OSY):
 - 1. Comply with MSS SP-70, Type I.
 - 2. Body Material: Gray iron with bolted bonnet.
 - 3. Ends: Flanged.
 - 4. Trim: Bronze.
 - 5. Disc: Solid wedge.
 - 6. Packing and Gasket: Asbestos free.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve be determined to be defective, replace with new valve.

3.02 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- C. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- D. Install swing check valves horizontal maintaining hinge pin level.

END OF SECTION 23 0523

SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components.
- B. Metal Channel (Strut) Framing Systems.
- C. Hanger Rods.
- D. Steel Cable.
- E. Pipe Supports.
- F. Insulation Clamps.
- G. Pipe Hangers.
- H. Pipe Shields for Insulated Piping.
- I. Anchors and Fasteners.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping.
- D. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- F. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
- G. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- H. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- I. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- J. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- K. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- M. MFMA-4 - Metal Framing Standards Publication.
- N. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.05 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- D. Delegated-Design Submittal: Provide for each anchor, alignment guide, trapeze pipe hanger, and equipment support to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer.
 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
- E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications for Field-Welding.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.

4. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE 7.
 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use stainless steel unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation.
 - b. Unistrut, a brand of Atkore International Inc.
 - c. PHD Manufacturing, Inc.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 2. Provide factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 3. Comply with MFMA-4.
 4. Channel Material:
 - a. Indoor Dry Locations: Use galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use stainless steel.
- C. Hanger Rods:
1. Threaded zinc-plated steel unless otherwise indicated.
- D. Steel Cable:
1. Manufacturers:
 - a. Ductmate Industries, Inc, a DMI Company.
 - b. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
- E. Pipe Supports:
1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
 2. Liquid Temperatures Up To 122 degrees F:
 - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
 - b. Support From Below: MSS SP-58 Types 35 through 38.
- F. Insulation Clamps:
1. Two bolt-type clamps designed for installation under insulation.
 2. Material: Carbon steel with epoxy copper or zinc finish.
- G. Pipe Hangers:
1. Hangers:
 - a. Provide hinged split ring and yoke roller hanger with epoxy copper or plain finish.
 - b. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
 - c. Provide hanger rod and nuts of the same type and material for a given pipe run.
 - d. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.

- H. Pipe Shields for Insulated Piping:
 - 1. MSS SP-58 Type 40, ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel
 - 2. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
 - d. Minimum Service Temperature: Minus 40 degrees F.
 - e. Maximum Service Temperature: 178 degrees F.
 - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- I. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 4. Hollow Masonry: Use toggle bolts.
 - 5. Hollow Stud Walls: Use toggle bolts.
 - 6. Sheet Metal: Use sheet metal screws.
 - 7. Wood: Use wood screws.
 - 8. Plastic and lead anchors are not permitted.
 - 9. Powder-actuated fasteners are not permitted.
 - 10. Hammer-driven anchors and fasteners are not permitted.
 - 11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 4 inch high concrete pad.
5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- G. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. See Division 01 for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 23 0529

SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.

1.03 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Heat Transfer Equipment: Nameplates.
- F. Instrumentation: Tags.
- G. Major Control Components: Nameplates.
- H. Piping: Pipe markers.
- I. Pumps: Nameplates.
- J. Small-sized Equipment: Tags.
- K. Tanks: Nameplates.
- L. Valves: Tags and adhesive laminated tape where located above lay-in ceiling .
- M. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Advanced Graphic Engraving, LLC.
 - 2. Brimar Industries, Inc.
 - 3. Kolbi Pipe Marker Co.
 - 4. Marking Services, Inc.
 - 5. Seton Identification Products, a Tricor Direct Company.
- B. Letter Color: White.
- C. Letter Height: 1/2 inch.
- D. Background Color: Black.
- E. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Kolbi Pipe Marker Co.
 - 5. Marking Services, Inc.
 - 6. Seton Identification Products, a Tricor Company.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Kolbi Pipe Marker Co.
 - 4. Seton Identification Products, a Tricor Company.
- B. Color: Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- E. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Use tags on piping 3/4 inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 23 0553

**SECTION 23 0590
PRESSURE TESTING FOR HVAC SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure Testing of Piping Systems

1.02 RELATED REQUIREMENTS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC .
- B. Test and Evaluation Reports:
 - 1. Certificate of completion, inspection, and test by authority having jurisdiction on required systems.
 - 2. Certificate of test approval by Owner's representative for all systems.
 - 3. Test Reports:
 - a. Description of testing procedure.
 - b. Results of tests, including recommendations for actions to remedy any deficiencies identified.

1.04 QUALITY ASSURANCE

- A. Code Compliance: perform required test in the presence of the authority having jurisdiction.
- B. Owner Witness: Perform tests in the presence of the Owner's representative.
- C. Engineer Witness: The Engineer or Engineer's representative reserves the right to observe test or selected tests to assure compliance with the specifications.
- D. Simultaneous Testing: Test observations by the authority having jurisdiction, the Owner's representative, and the Engineer's representative need not occur simultaneously.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL

- A. Piping:
 - 1. Test prior to concealment, insulation being applied, and connection to equipment, fixtures, or specialties.
 - 2. Conduct test with all valves except those used to isolate the test section 10 percent closed.
- B. Leaks: Repair all leaks and retest until stipulated end results are achieved.
- C. Notification:
 - 1. Advice Architect 72 hours in advance of each test.
 - 2. Failure to notify will require test to be rescheduled.
- D. Testing Equipment: Provide all necessary pumps, gauges, connections, and similar items required to perform the tests.

3.02 TESTING REQUIREMENTS

- A. Piping:
 - 1. General: Test all piping as noted below, and with no leaks or loss in pressure for time indicated.
 - a. Heating Water Systems:
 - 1) Test Pressure: 150 psig
 - 2) Test Medium: Water

3) Test Duration: 4 hours

END OF SECTION 23 0590

SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic systems.
- C. Measurement of final operating condition of HVAC systems.

1.02 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
- C. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing.

1.03 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - 2. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Identification and types of measurement instruments to be used and their most recent calibration date.
 - d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - e. Final test report forms to be used.
 - f. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - g. Expected problems and solutions, etc.
 - h. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - 2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
 - i. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - j. Confirmation of understanding of the outside air ventilation criteria under all conditions.

- k. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - l. Method of checking building static and exhaust fan and/or relief damper capacity.
 - m. Time schedule for TAB work to be done in phases (by floor, etc.).
 - n. Description of TAB work for areas to be built out later, if any.
 - o. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - p. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - q. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Field Logs: Submit at least twice a week to the Construction Manager.
- E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- F. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 3. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 - 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 6. Units of Measure: Report data in I-P (inch-pound) units only.
 - 7. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Architect.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Project altitude.
 - j. Report date.
- G. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. SMACNA (TAB).
 - 3. Maintain at least one copy of the standard to be used at project site at all times.

- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place.
 - 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
 - 1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- C. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

- M. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
- N. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.07 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Fire Pumps.
 - 2. Sprinkler Air Compressor.
 - 3. HVAC Pumps.
 - 4. Water Tube Boilers.
 - 5. Packaged Steel Water Tube Boilers.
 - 6. Packaged Steel Fire Tube Boilers.
 - 7. Forced Air Furnaces.
 - 8. Direct Fired Furnaces.
 - 9. Air Cooled Water Chillers.
 - 10. Centrifugal Water Chillers.
 - 11. Induced Draft Cooling Tower.
 - 12. Packaged Roof Top Heating/Cooling Units.
 - 13. Packaged Terminal Air Conditioning Units.
 - 14. Unit Air Conditioners.
 - 15. Computer Room Air Conditioning Units.
 - 16. Air Coils.
 - 17. Terminal Heat Transfer Units.
 - 18. Air Handling Units.
 - 19. Fans.
 - 20. Air Filters.
 - 21. Air Terminal Units.
 - 22. Air Inlets and Outlets.

3.09 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer.
 - 2. Model/Frame.
 - 3. HP/BHP.
 - 4. Phase, voltage, amperage; nameplate, actual, no load.
 - 5. RPM.

6. Service factor.
 7. Starter size, rating, heater elements.
 8. Sheave Make/Size/Bore.
- B. V-Belt Drives:
1. Identification/location.
 2. Required driven RPM.
 3. Driven sheave, diameter and RPM.
 4. Belt, size and quantity.
 5. Motor sheave diameter and RPM.
 6. Center to center distance, maximum, minimum, and actual.
- C. Pumps:
1. Identification/number.
 2. Manufacturer.
 3. Size/model.
 4. Impeller.
 5. Service.
 6. Design flow rate, pressure drop, BHP.
 7. Actual flow rate, pressure drop, BHP.
 8. Discharge pressure.
 9. Suction pressure.
 10. Total operating head pressure.
 11. Shut off, discharge and suction pressures.
 12. Shut off, total head pressure.
- D. Combustion Equipment:
1. Manufacturer.
 2. Model number.
 3. Serial number.
 4. Firing rate.
 5. Overfire draft.
 6. Gas meter timing dial size.
 7. Gas meter time per revolution.
 8. Gas pressure at meter outlet.
 9. Gas flow rate.
 10. Heat input.
 11. Burner manifold gas pressure.
 12. Percent carbon monoxide (CO).
 13. Percent carbon dioxide (CO₂).
 14. Percent oxygen (O₂).
 15. Percent excess air.
 16. Flue gas temperature at outlet.
 17. Ambient temperature.
 18. Net stack temperature.
 19. Percent stack loss.
 20. Percent combustion efficiency.
 21. Heat output.
- E. Air Cooled Condensers:
1. Identification/number.
 2. Location.
 3. Manufacturer.
 4. Model number.

5. Serial number.
 6. Entering DB air temperature, design and actual.
 7. Leaving DB air temperature, design and actual.
 8. Number of compressors.
- F. Chillers:
1. Identification/number.
 2. Manufacturer.
 3. Capacity.
 4. Model number.
 5. Serial number.
 6. Evaporator entering water temperature, design and actual.
 7. Evaporator leaving water temperature, design and actual.
 8. Evaporator pressure drop, design and actual.
 9. Evaporator water flow rate, design and actual.
 10. Condenser entering water temperature, design and actual.
 11. Condenser pressure drop, design and actual.
 12. Condenser water flow rate, design and actual.
- G. Cooling Tower:
1. Tower identification/number.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Rated capacity.
 6. Entering air WB temperature, specified and actual.
 7. Leaving air WB temperature, specified and actual.
 8. Ambient air DB temperature.
 9. Condenser water entering temperature.
 10. Condenser water leaving temperature.
 11. Condenser water flow rate.
 12. Fan RPM.
- H. Heat Exchangers:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Model number.
 6. Serial number.
 7. Steam pressure, design and actual.
 8. Primary water entering temperature, design and actual.
 9. Primary water leaving temperature, design and actual.
 10. Primary water flow, design and actual.
 11. Primary water pressure drop, design and actual.
 12. Secondary water leaving temperature, design and actual.
 13. Secondary water flow, design and actual.
 14. Secondary water pressure drop, design and actual.
- I. Cooling Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.

5. Air flow, design and actual.
 6. Entering air DB temperature, design and actual.
 7. Entering air WB temperature, design and actual.
 8. Leaving air DB temperature, design and actual.
 9. Leaving air WB temperature, design and actual.
 10. Water flow, design and actual.
 11. Water pressure drop, design and actual.
 12. Entering water temperature, design and actual.
 13. Leaving water temperature, design and actual.
 14. Saturated suction temperature, design and actual.
 15. Air pressure drop, design and actual.
- J. Heating Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Water flow, design and actual.
 7. Water pressure drop, design and actual.
 8. Entering water temperature, design and actual.
 9. Leaving water temperature, design and actual.
 10. Entering air temperature, design and actual.
 11. Leaving air temperature, design and actual.
 12. Air pressure drop, design and actual.
- K. Electric Duct Heaters:
1. Manufacturer.
 2. Identification/number.
 3. Location.
 4. Model number.
 5. Design kW.
 6. Number of stages.
 7. Phase, voltage, amperage.
 8. Test voltage (each phase).
 9. Test amperage (each phase).
 10. Air flow, specified and actual.
 11. Temperature rise, specified and actual.
- L. Air Moving Equipment:
1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Arrangement/Class/Discharge.
 6. Air flow, specified and actual.
 7. Return air flow, specified and actual.
 8. Outside air flow, specified and actual.
 9. Total static pressure (total external), specified and actual.
 10. Inlet pressure.
 11. Discharge pressure.
 12. Sheave Make/Size/Bore.
 13. Number of Belts/Make/Size.

14. Fan RPM.
- M. Return Air/Outside Air:
 1. Identification/location.
 2. Design air flow.
 3. Actual air flow.
 4. Design return air flow.
 5. Actual return air flow.
 6. Design outside air flow.
 7. Actual outside air flow.
 8. Return air temperature.
 9. Outside air temperature.
 10. Required mixed air temperature.
 11. Actual mixed air temperature.
 12. Design outside/return air ratio.
 13. Actual outside/return air ratio.
- N. Exhaust Fans:
 1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Air flow, specified and actual.
 6. Total static pressure (total external), specified and actual.
 7. Inlet pressure.
 8. Discharge pressure.
 9. Sheave Make/Size/Bore.
 10. Number of Belts/Make/Size.
 11. Fan RPM.
- O. Duct Traverses:
 1. System zone/branch.
 2. Duct size.
 3. Area.
 4. Design velocity.
 5. Design air flow.
 6. Test velocity.
 7. Test air flow.
 8. Duct static pressure.
 9. Air temperature.
 10. Air correction factor.
- P. Duct Leak Tests:
 1. Description of ductwork under test.
 2. Duct design operating pressure.
 3. Duct design test static pressure.
 4. Duct capacity, air flow.
 5. Maximum allowable leakage duct capacity times leak factor.
 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 7. Test static pressure.

8. Test orifice differential pressure.
 9. Leakage.
- Q. Air Monitoring Stations:
1. Identification/location.
 2. System.
 3. Size.
 4. Area.
 5. Design velocity.
 6. Design air flow.
 7. Test velocity.
 8. Test air flow.
- R. Flow Measuring Stations:
1. Identification/number.
 2. Location.
 3. Size.
 4. Manufacturer.
 5. Model number.
 6. Serial number.
 7. Design Flow rate.
 8. Design pressure drop.
 9. Actual/final pressure drop.
 10. Actual/final flow rate.
 11. Station calibrated setting.
- S. Terminal Unit Data:
1. Manufacturer.
 2. Type, constant, variable, single, dual duct.
 3. Identification/number.
 4. Location.
 5. Model number.
 6. Size.
 7. Minimum static pressure.
 8. Minimum design air flow.
 9. Maximum design air flow.
 10. Maximum actual air flow.
 11. Inlet static pressure.
- T. Air Distribution Tests:
1. Air terminal number.
 2. Room number/location.
 3. Terminal type.
 4. Terminal size.
 5. Area factor.
 6. Design velocity.
 7. Design air flow.
 8. Test (final) velocity.
 9. Test (final) air flow.
 10. Percent of design air flow.

END OF SECTION 23 0593

**SECTION 23 0713
DUCT INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.
- C. Acoustical wrap

1.02 RELATED REQUIREMENTS

- A. Section 23 0553 - Identification for HVAC Piping and Equipment.
- B. Section 23 3100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
- E. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- G. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 QUALITY ASSURANCE

- A. Prohibit insulating products from containing pentabrominated, octabrominated, and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
- B. Source Quality Control:
 - 1. Insulation and accessories not to provide nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, not to react corrosively with equipment, piping, or ductwork, and asbestos free.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions during and after installation as required by manufacturers of adhesives, mastics, and insulation cements.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50 for insulation installed indoors and within ductwork and 75/150 for insulation installed outdoors, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. Johns Manville.
 - 2. Knauf Insulation.
 - 3. Owens Corning Corporation.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. 'K' value: 0.25 at 75 degrees F BTU-IN/HR-SF-deg F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 250 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape: Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F.
 - 1. Manufacturers:
 - a. Zeston.
 - b. Substitutions: Submit substitution request.
 - 2. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film with pressure-sensitive rubber-based adhesive.
- E. Tie Wire: Annealed steel, 20 gage, 0.0508 inch diameter at 24 inches on center and at all joints.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. Johns Manville.
 - 2. Knauf Insulation.
 - 3. Owens Corning Corporation.
 - 4. Micro-Aire.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
 - 1. K Value: 0.24 at 75 degrees F BTU-IN/HR-SF-deg F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 250 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent.
 - 4. Maximum Density: 4.0 lb/cu ft.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.

3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape: Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F.
 1. Manufacturers:
 - a. Zeston.
 - b. Substitutions: Submit substitution request.
 2. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film with pressure-sensitive rubber-based adhesive.

2.04 DUCT LINER

- A. Manufacturers:
 1. Johns Manville.
 2. Knauf Insulation.
 3. Owens Corning Corporation.
- B. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
 1. Fungal Resistance: No growth when tested according to ASTM G21.
 2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
 3. Service Temperature: Up to 250 degrees F.
 4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
 5. Minimum Noise Reduction Coefficients:
 - a. 1 inch Thickness: 0.45.
 - b. 1-1/2 inches Thickness: 0.60.
 - c. 2 inch Thickness: 0.70.
- C. Adhesive: Waterproof, fire-retardant type, ASTM C916. Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
 1. Manufacturers:
 - a. Foster.
 - b. Design Polymerics.
- D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

2.05 ACOUSTICAL WRAP

- A. Barrier:
 1. Construct barrier of a 0.10-inch thick mass loaded, limp vinyl sheet bonded to a layer of reinforced aluminum foil on one side.
 2. Nominal density of 2 pound per square-foot and minimum STC rating of 34.
 3. Minimum thermal conductivity value of 0.11 BTU-IN/HR-SF-deg F and a rated service temperature range of -20 degrees F to 200 degrees F.
 4. Flame spread index of no more than 25 and a smoke development index of less than 50.
- B. Decoupling Layer:
 1. Combination of fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together in a matrix of 4-inch diamond stitch pattern, which encapsulates the glass fibers.
- C. Composite Material:
 1. Fabricated to include a nominal 6-inch wide barrier overlap tab extending beyond the quilted fiberglass to facilitate a leak-tight seal around field joints.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test ductwork for design pressure prior to applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated Ducts Conveying Air Below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- D. Insulated Ducts Conveying Air Above Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- E. Ducts Exposed in Mechanical Equipment Rooms: Finish with canvas jacket sized for finish painting.
- F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
- G. Slope exterior ductwork to shed water.
- H. External Blanket Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Joints and seams lapped a minimum of 3 inches.
 - 3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- I. Duct and Plenum Liner Application:
 - 1. Adhere insulation with adhesive for 100 percent coverage.
 - 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
 - 3. Seal and smooth joints. Seal and coat transverse joints.
 - 4. Seal liner surface penetrations with adhesive.
 - 5. Duct dimensions indicated are net inside dimensions required for air-flow. Increase duct size to allow for insulation thickness.
- J. Existing Insulation:
 - 1. Repair existing insulation damaged during construction.
 - 2. Make neat connections where new and existing insulation meet.
 - 3. Where existing piping, ductwork, or equipment is removed, cover existing surfaces neatly to match existing.
 - 4. Where existing insulation is damaged or missing, notify the Architect prior to performing the work.

3.03 SCHEDULES

- A. Combustion Air Duct:
 - 1. Duct Insulation, Glass Fiber: 2 inches thick.
- B. Ducts as part of the thermal envelope, from exterior to automatic shutoff damper:
 - 1. Concealed locations:
 - a. Duct Insulation, Glass Fiber: 5 inches thick.
- C. Outside Air Intake Ducts, downstream of automatic shutoff damper:
 - 1. Concealed locations:

- a. Duct Insulation, Glass Fiber: 3 inches thick.
- 2. Exposed locations:
 - a. Duct Liner, Glass Fiber: 3 inches thick.
- D. Supply Ducts:
 - 1. Medium Pressure:
 - a. Within 15 feet of fan:
 - 1) Duct Liner, Glass Fiber: 1-1/2 inches thick.
 - b. Concealed locations:
 - 1) Duct Insulation, Glass Fiber: 1-1/2 inches thick.
 - c. Exposed locations:
 - 1) Duct Liner, Glass Fiber: 1-1/2 inches thick.
 - 2. Low Pressure:
 - a. Within 15 feet of fan:
 - 1) Duct Liner, Glass Fiber: 1-1/2 inches thick.
 - b. Duct Insulation, Glass Fiber: 1-1/2 inches thick.
 - c. Concealed locations:
 - 1) Duct Insulation, Glass Fiber: 1-1/2 inches thick.
 - d. Exposed locations:
 - 1) Duct Liner, Glass Fiber: 1-1/2 inches thick.
 - e. Downstream of terminal units:
 - 1) Duct Liner, Glass Fiber: 1-1/2 inches thick.
- E. Return Ducts:
 - 1. Within 15 feet of fan:
 - a. Duct Liner, Glass Fiber: 1-1/2 inches thick.
 - 2. Duct Liner, Glass Fiber: 1 inches thick.
- F. Exhaust Ducts:
 - 1. Within 15 feet of fan:
 - a. Duct Liner, Glass Fiber: 1 inches thick.
 - 2. Within 10 feet downstream of grilles serving restrooms:
 - a. Duct Liner, Glass Fiber: 1 inches thick.
- G. Transfer Ducts: Duct Liner, Glass Fiber: 1 inches thick.
- H. Supply Plenums: Duct Liner, Glass Fiber: 2 inches thick.
- I. Return Plenums: Duct Liner, Glass Fiber: 2 inches thick.
- J. Acoustical Wrap:
 - 1. Terminal Units with maximum air volumes exceeding 2,000 cfm.
 - 2. Where indicated on drawings.

END OF SECTION 23 0713

**SECTION 23 0716
HVAC EQUIPMENT INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment insulation.
- B. Glass fiber, flexible.
- C. Flexible elastomeric cellular insulation.
- D. Breeching insulation.

1.02 RELATED REQUIREMENTS

- A. Section 23 0553 - Identification for HVAC Piping and Equipment.
- B. Section 23 2113 - Hydronic Piping.
- C. Section 23 2114 - Hydronic Specialties.

1.03 REFERENCE STANDARDS

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- E. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- G. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
- H. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- J. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturers:
 - 1. Johns Manville Corporation.
 - 2. Knauf Insulation.
 - 3. Owens Corning Corp.
- B. Insulation: ASTM C553; flexible, noncombustible.
 - 1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 1,000 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 2. Secure with outward clinch expanding staples and vapor barrier mastic.
- D. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.03 HYDROUS CALCIUM SILICATE

- A. Manufacturer:
 - 1. Johns Manville Corporation.
- B. Insulation: ASTM C533; rigid molded, asbestos free, gold color.
 - 1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 1,200 degrees F.
 - 3. Density: 15 pcf.
- C. Tie Wire: 0.048 inches stainless steel with twisted ends on maximum 12 inch centers.
- D. Insulating Cement: ASTM C449.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Aeroflex USA, Inc.
 - 2. Armacell LLC.
 - 3. K-Flex USA LLC.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Insulated equipment containing fluids below ambient temperature; insulate entire system.
- G. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.
- H. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- I. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- J. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.
- K. Inserts and Shields:
 - 1. Application: Equipment 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between hangers and inserts.
 - 3. Insert Location: Between support shield and equipment and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- L. Finish insulation at supports, protrusions, and interruptions.
- M. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.
- N. Exterior Applications:
 - 1. Provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement.
 - 2. Cover with aluminum.
- O. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.
- P. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- Q. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

3.03 SCHEDULE

- A. Heating Systems:
 - 1. Air Separators: Flexible removable and reusable blanket insulation. 2 inch thick.
 - 2. Expansion Tanks: Glass fiber, flexible insulation. 2 inch thick.
- B. Cooling Systems:
 - 1. Air Separators: Flexible elastomeric cellular insulation. 2 inch thick.

2. Expansion Tanks: Flexible elastomeric cellular insulation. 2 inch thick.

END OF SECTION 23 0716

**SECTION 23 0719
HVAC PIPING INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glass fiber, rigid.
- B. Flexible elastomeric cellular.
- C. Jacketing and accessories.
- D. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

- A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- D. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- F. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
- G. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- H. ASTM D610 - Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- J. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Insulating products containing pentabrominated, octabrominated, and decabrominated diphenyl ethers are prohibited. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
- B. Insulation and accessories providing nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin are prohibited.
- C. Insulation and accessories containing asbestos are prohibited.
- D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- E. Applicator Qualifications: Company specializing in performing the type of work specified in this section and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions during and after installation as required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50 for insulation installed indoors and 75/150 for insulation installed outdoors, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

- A. Manufacturers:
 - 1. Johns Manville Corporation.
 - 2. Knauf Insulation.
 - 3. Owens Corning Corporation.
- B. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. 'K' Value: ASTM C177, 0.23 at 75 degrees F BTU-IN/HR-SF-deg F.
 - 2. Maximum Service Temperature: 650 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.
- F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- G. Fibrous Glass Fabric:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
 - 2. Blanket: 1.0 pcf density.
 - 3. Weave: 5 by 5.
- H. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, black color.
- I. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- J. Insulating Cement: ASTM C449.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Rubatex.
 - 2. Armacell LLC.
 - 3. K-Flex USA LLC.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1 with fitting covers and paintable surface.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.

3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.04 JACKETING AND ACCESSORIES

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 1. Lagging Adhesive: Compatible with insulation.
- B. Aluminum Jacket:
 1. Thickness: 0.016 inch sheet.
 2. Finish: Embossed.
 3. Joining: Longitudinal slip joints and 2 inch laps.
 4. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

2.05 ACCESSORIES

- A. General Requirements:
 1. Provide required accessories in accordance with and subject to the recommendations of the insulation manufacturer.
 2. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.
 3. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
 4. Supply materials that are asbestos free.
- B. Corrosion Inhibitors:
 1. Corrosion Control Gel:
 - a. Corrosion Protection: Comply with ASTM B117 and ASTM D610.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Joints: Coat both sides of complete joining area with applicable adhesive.
 1. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch wide tape.
 2. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch wide tape or butt straps.
 3. Multiple Layered Insulation: Joints staggered.
- E. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
- F. Voids:
 1. Fill voids, chipped corners and other openings with insulating cement or material compatible with insulating material.
- G. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- H. Unions and flanges need not be insulated on the following systems:
 1. High, medium, and low pressure steam, inside building, 2-inch and smaller.
 2. Condensate, pumped condensate, feed water, inside building.
- I. The following piping is not insulated:
 1. Refrigerant relief valve discharge.

2. Condenser water, inside building, except where used for water side economizer.
 3. Steam safety valve discharge higher than 8-feet above floor.
 4. Steam vents from condensate, higher than 8-feet above floor pumps, deaerators, etc.
 5. Steam traps.
- J. Glass fiber insulated pipes conveying fluids below 65 degrees F:
1. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- K. Glass fiber insulated pipes conveying fluids above 65 degrees F:
1. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- L. Inserts and Shields:
1. Application: Piping 1-1/2 inches diameter or larger.
 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 3. Insert location: Between support shield and piping and under the finish jacket.
 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- M. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 8400.
- N. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation.
- O. Buried Piping: Provide factory-fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.
- P. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Bed heat tape into heat transfer cement with insulation over heat tape and cement. Size large enough to enclose pipe and heat tracer.

3.03 SCHEDULE

- A. Heating Systems:
1. Heating Water Supply and Return: Glass Fiber.
 - a. Pipe size less than 1-1/2 inches: 1 inch thick.
 - b. Pipe size greater than or equal to 1-1/2 inches: 1-1/2 inches thick.
- B. Cooling Systems:
1. Chilled Water: Glass Fiber.
 - a. Pipe size less than 1-1/2 inches: 1/2 inch thick.
 - b. Pipe size greater than or equal to 1-1/2 inches: 1 inch thick.
 2. Cold Condensate Drains: Flexible Elastomeric Cellular.
 - a. 1/2 inch thick.
 3. Condensate Drains from Cooling Coils: Flexible Elastomeric Cellular.
 - a. 1/2 inch thick.
 4. Refrigerant Suction: Flexible Elastomeric Cellular.
 - a. Pipe size less than 1 inch: 1/2 inch thick (CA Residential applications 3/4 inch thick).
 - b. Pipe size greater than or equal to 1 inch: 1 inch thick.
 5. Refrigerant Hot Gas: Flexible Elastomeric Cellular.

- a. Pipe size less than 1 inch: 1/2 inch thick.
- b. Pipe size greater than or equal to 1 inch: 1 inch thick.

END OF SECTION 23 0719

**SECTION 23 0913
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Control panels.
- B. Control Valves:
 - 1. Ball valves and actuators.
 - 2. Globe pattern.
 - 3. Butterfly pattern.
- C. Pressure independent valves and actuators.
- D. Control Valve Operators:
 - 1. Electronic operators.
- E. Dampers.
- F. Damper Operators:
 - 1. Electric operators.
- G. Input/Output Sensors:
 - 1. Temperature sensors.
 - 2. Static pressure (air pressure) sensors.
 - 3. Equipment operation (current) sensors.
 - 4. Digital to pneumatic transducers.
 - 5. Damper position indicators.
 - 6. Nitrogen dioxide sensors.
 - 7. Carbon monoxide sensors.
 - 8. Carbon dioxide sensors.
 - 9. Refrigerant sensors.
 - 10. Emergency stop switch.
 - 11. Piping pressure transmitter.
- H. Thermostats:
 - 1. Electric room thermostats.
 - 2. Low-limit temperature cutout switch (freezestat).
 - 3. Line voltage thermostats.
 - 4. Room thermostat accessories.
 - 5. Outdoor reset thermostats.
 - 6. Immersion thermostats.
 - 7. Airstream thermostats.
 - 8. Electric low limit duct thermostats.
 - 9. Electric high limit duct thermostats.
 - 10. Fire thermostats.
 - 11. Heating/cooling valve top thermostats.
- I. Time clocks.
- J. Transmitters:
 - 1. Building static pressure transmitters.
 - 2. Pressure transmitters.
 - 3. Air pressure transmitters.
 - 4. Water pressure transmitters (liquid differential pressure transmitters).
 - 5. Temperature transmitters.
 - 6. Humidity transmitters.
- K. Transducers:

1. Electropneumatic transducers.
- L. Flow Sensors:
 1. Flow nozzles.
 2. Venturi tubes.
 3. Airflow measurement array (AFMA).
 4. Annular pitot tubes.
 5. Orifice plates.
 6. Ultrasonic flow meters.
 7. Insertion turbine meters.
 8. Insertion magnetic flow meters.
 9. Paddle type flow meters.
 10. Vortex shedding flow meters.
 11. Positive displacement flow meters.
 12. Gas flow meters.
 13. Flow switches.

1.02 RELATED REQUIREMENTS

- A. Section 23 0519 - Meters and Gauges for HVAC Piping.
- B. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- C. Section 23 0923 - Direct-Digital Control System for HVAC.
- D. Section 23 2113 - Hydronic Piping.
- E. Section 23 2114 - Hydronic Specialties.
- F. Section 23 3300 - Air Duct Accessories.
- G. Section 26 0583 - Wiring Connections.
- H. Section 26 2726 - Wiring Devices.

1.03 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
- B. ANSI/FCI 70-2 - Control Valve Seat Leakage.
- C. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
- D. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code).
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats.
- G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- H. UL 2075 - Standard for Gas and Vapor Detectors and Sensors.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Shop Drawings:
 1. Prepare in AutoCAD format, include the following:
 - a. Operating data
 - b. System drawings
 - 1) Instrumentation and control diagrams

- 2) List of connected data points, including DDC panels to which they are connected, and input device (sensor, etc.)
- c. Wiring diagrams
 - 1) Details of connections to power sources, including grounding
 - 2) Details of surge protection device installations
- d. Written, detailed operational description of sequences
- e. System graphics
- f. Schedule of valves, include the following:
 - 1) Size
 - 2) Flow
 - 3) Pressure drop
 - 4) Operator type
- g. Schedule of automatic dampers, include the following:
 - 1) Arrangement
 - 2) Velocities
 - 3) Static pressure drop
 - 4) Operator type
- D. Design Data: Provide design data for sizing and selection of compressor.
- E. Manufacturer's Instructions: Provide for all manufactured components.
- F. Designer's qualification statement.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.
- I. Operation and Maintenance Manuals:
- J. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
- K. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- L. Valve schedule indicating flow, pressure drop, CVs, and actuator type.
- M. Damper schedule indicating flow, pressure drop, CVs, and actuator type.
- N. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Thermostats and Other Exposed Sensors: One of each type.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State in which the Project is located.
- 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 documented experience approved by manufacturer.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 WARRANTY

- A. See Section 23 0500 - Common Work Results for HVAC for additional warranty requirements.
- B. Correct defective work within a five year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for control air compressors.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels.

2.03 CONTROL VALVES

- A. Ball Valves and Actuators:
 - 1. Service: Use for brine (30 percent glycol), chilled water, or hot water.
 - 2. Flow Characteristic: Include 2-way, 3-way diverting, 3-way mixing, and 6-way (with pressure relief in closed position) operation configured to fail as indicated on drawings.
 - 3. Replacements in Kind: Provide pressure-independent type.
 - 4. Rangeability: 500 to 1.
 - 5. ANSI Rating: Class 150.
 - 6. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
 - 7. Body Size:
 - a. Under 2-1/2 inches:
 - 1) Connection: Union sweat.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: Chrome-plated brass.
 - (d) Stem: Nickel-plated brass.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - b. Service Temperature:
 - 1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.
 - 2) Ambient Side: From minus 4 to 122 degrees F.
 - 8. Actuator Requirements:
 - a. Assembly: Factory-mounted.
 - b. Input: 4 to 20 mA configured as indicated on drawings.
 - c. Accessories: Provide with valve position indicator and manual override.
- B. Globe Pattern:
 - 1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 - 2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
 - 3. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Replaceable plugs and seats of stainless steel.
 - c. Size for 5 psig maximum pressure drop at design flow rate.
 - 1) Two-way valves: Equal percentage characteristics.
 - 2) Three-way valves: Linear characteristics.

- C. Butterfly Pattern:
 - 1. Iron body, bronze disc, resilient replaceable seat for service to 180 degrees F wafer or lug ends, extended neck.
 - 2. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Size for 1 psig maximum pressure drop at design flow rate.

2.04 CONTROL VALVE OPERATORS

- A. Electronic Operators:
 - 1. Provide valve spring return to normal position as indicated on freeze, fire, or temperature protection.
 - 2. Select operator for full shut off at maximum pump differential pressure.
 - 3. Brushless DC motor with enclosed gear train, protected from overload at all angles of rotation.
 - 4. Position indicator.
 - 5. Power: 24 VDC or 24 VAC.
 - 6. External adjustable stops to limit the travel in either direction.
 - 7. Modulating: Accept 0-10 VDC or 2-10 VDC or 4-20 mA input signal.
 - 8. Clamp position feedback signal of 2-10 VDC, independent of the input signal, and may be used to parallel other actuators and provide true position indication.

2.05 PRESSURE INDEPENDENT VALVES AND ACTUATORS

- A. Size 2 inch and Smaller:
 - 1. Provide globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
 - 2. Metal construction materials consist of bronze or brass.
 - 3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- B. Size 2.5 inch and Larger:
 - 1. Provide globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged connections.
 - 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 - 3. Internal components construction materials consist of brass or bronze.
- C. Actuator Requirements:
 - 1. Assembly: Factory-mounted.
 - 2. Input: 4 to 20 mA configured as indicated on drawings.
 - 3. Accessories: Provide with manual override and valve position indicator.

2.06 DAMPERS

- A. Performance: Test in accordance with AMCA 500-D.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gauge, 0.1046 inch.
- C. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gauge, 0.0299 inch, attached to minimum 1/2 inch shafts with set screws.
- D. Blade Seals: Synthetic elastomeric, inflatable, mechanically attached, field replaceable.
- E. Jamb Seals: Spring stainless steel.
- F. Shaft Bearings: Oil impregnated sintered bronze.
- G. Linkage Bearings: Oil impregnated sintered bronze.
- H. Leakage: Less than 4 cfm/sf at 1-inch static pressure.
- I. Maximum Pressure Differential: 6 inches wg.
- J. Temperature Limits: Minus 40 to 200 degrees F.

2.07 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - 1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 - 2. Provide one operator for maximum 36 sq ft damper section.
- B. Electric Operators:
 - 1. Brushless DC motor with enclosed gear train, protected from overload at all angles of rotation.
 - 2. Position indicator.
 - 3. Power: 24 VDC or 24 VAC.
 - 4. External adjustable stops to limit the travel in either direction.
 - 5. Modulating: Accept 0-10 VDC or 2-10 VDC or 4-20 mA input signal.
 - 6. Clamp position feedback signal of 2-10 VDC, independent of the input signal, and may be used to parallel other actuators and provide true position indication.

2.08 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
 - 1. Use RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
 - 2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
 - 3. Temperature Sensing Device: Compatible with project DDC controllers.
 - 4. Performance Characteristics:
 - a. RTD:
 - 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
 - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
 - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
 - 4) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
 - 5) Range: Minus 40 degrees F through 220 degrees F minimum.
 - b. Temperature Transmitter:
 - 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
 - 2) Output: 4 to 20 mA.
 - c. Sensing Range:
 - 1) Provide limited range sensors if required to sense the range expected for a respective point.
 - 2) Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
 - d. Wire Resistance:
 - 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
 - 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
 - e. Room Sensors: Locking cover matching the pneumatic thermostats used.
 - f. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 - g. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.

- h. Ceiling and Recessed Mount Temperature Sensors: Ceiling-mounted sensor in a low-profile housing.
 - i. Room Security Sensors: Stainless steel cover plate with insulated back and security screws.
 - j. Room Temperature Sensors:
 - 1) Construct for surface, wall box, or _____ mounting.
 - 2) Provide the following:
 - (a) Setpoint reset slide switch with an adjustable temperature range.
 - (b) Individual heating/cooling setpoint slide switches.
 - (c) Momentary override request push button for activation of after-hours operation.
 - (d) Analog thermometer.
 - k. Room Temperature Sensors with Integral Digital Display:
 - 1) Construct for surface, wall box, or _____.
 - 2) Provide a four button keypad with the following capabilities:
 - (a) Indication of space and outdoor temperatures.
 - (b) Setpoint adjustment to accommodate room setpoint, DDC Input/Output Points List, Sequence of Operation, and _____.
 - (c) Display and control fan operation status.
 - (d) Manual occupancy override and indication of occupancy status.
 - (e) Controller mode status.
 - (f) Password enabled setpoint and override modes.
 - l. Temperature Averaging Elements:
 - 1) Use on duct sensors for ductwork 10 sq ft or larger.
 - 2) Use averaging elements where prone to stratification with sensor length 8 ft, 16 ft, or _____ ft.
 - 3) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
 - m. Insertion Elements:
 - 1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
 - 2) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.
- B. Static Pressure (Air Pressure) Sensors:
- 1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 - 2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 - 3. Accuracy: One percent of full scale with repeatability 0.3 percent.
 - 4. Output: 0 to 5 vdc with power at 12 to 28 vdc.
- C. Equipment Operation (Current) Sensors:
- 1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
 - 2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
 - 3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- D. Digital to Pneumatic Transducers:
- 1. Convert plus or minus 12 vdc pulse width modulation outputs to 0 to 20 psi.
- E. Damper Position Indicators: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 to 100 percent damper travel.
- F. Nitrogen Dioxide Sensors, for Single-Gang Electrical Box Mounting:
- 1. General:
 - a. Provide gas platform, wired to the building controller, with replaceable sensor.

- b. Certification: UL 2075.
 - c. Input Power: Class 2; 15 to 30 VDC, plus/minus 20 percent, 50/60 Hz.
 - d. Relay Ratings: 1A/30VAC/DC, normally open.
 - e. Operating Temperature Range: Minus 4 degrees F to 122 degrees F.
 - f. Operating Humidity Range: 0 to 90 percent RH non-condensing.
 - g. Terminal Block Wire Size: 30 AWG (0.255 mm) to 12 AWG (2.05 mm).
 - h. Terminal Block Torque: 0.37 to 0.44 inch-lbf.
 - i. Protection Class: IP20 in accordance with IEC 60529.
2. Sensor:
- a. Sensor Type: Electrochemical.
 - b. Measurement Range: 0 to 15 ppm.
 - c. Accuracy: Plus/minus 3 percent of range at 25 degrees F.
 - d. Resolution: 0.1 ppm.
 - e. Sensor Warranty: 2 years from manufacture date.
 - f. Low Setpoint Value: 0.75 ppm(fixed).
 - g. High Setpoint Value: 2 ppm(fixed).
 - h. Operating Temperature Range: Minus 4 degrees F to 122 degrees F.
 - i. Operating Humidity Range: 0 to 90 percent RH non-condensing.
- G. Carbon Monoxide Sensors, for Single-Gang Electrical Box Mounting:
1. General:
- a. Provide gas platform, wired to the building controller, with replaceable sensor.
 - b. Certification: UL 2075.
 - c. Input Power: Class 2; 15 to 30 VDC/24 VAC plus/minus 20 percent, 50/60 Hz.
 - d. Relay Ratings: 1A/30VAC/DC, normally open.
 - e. Operating Temperature Range: Minus 4 degrees F to 122 degrees F.
 - f. Operating Humidity Range: 0 to 90 percent RH non-condensing.
 - g. Terminal Block Wire Size: 30 AWG (0.255 mm) by 12 AWG (2.05 mm).
 - h. Terminal Block Torque: 0.37 to 0.44 inch-lbf.
 - i. Protection Class: IP20 in accordance with IEC 60529.
2. Sensor:
- a. Sensor Type: Electrochemical.
 - b. Measurement Range: 0 to 200 ppm.
 - c. Accuracy: Plus/minus 5 percent of range.
 - d. Resolution: 1 ppm.
 - e. Sensor Warranty: 2 years from manufacture date.
 - f. Low Setpoint Value: 25 ppmswitch selectable.
 - g. High Setpoint Value: 180 ppm (fixed).
 - h. Operating Temperature Range: Minus 4 degrees F to 122 degrees F.
 - i. Operating Humidity Range: 0 to 90 percent RH non-condensing.
- H. Carbon Dioxide Sensors, Duct and Wall:
1. General: Provide non-dispersive infrared (NDIR), diffusion sampling CO2 sensors with integral transducers and linear output.
 2. Air Temperature: Range of 32 to 122 degrees F.
 3. Relative Humidity: Range of 0 to 95 percent (non-condensing).
 4. Power Input: Class 2; 12 to 30VDC or 24VAC 50/60 Hz; 100mA max.
 5. Calibration Characteristics:
 - a. Automatically compensating algorithm for sensor drift due to sensor degradation.
 - b. Maximum Drift: 2 percent.
 - c. User calibratable with a minimum calibration interval of 5 years.
 6. Construction:

- a. Sensor Chamber: Non-corrosive material for neutral effect on carbon dioxide sample.
- b. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
- c. Housing: High impact plastic.
- 7. Optional Equipment
 - a. Temperature Sensor:
 - 1) Solid state, integrated circuit; Accuracy: Plus/minus 1 degree F; Resolution: 0.2 degrees F; Output Range: 50 to 95 degrees F.
- I. Emergency Stop Switch: Red, mushroom type, pull out to operate.
- J. Piping Pressure Transmitter:
 - 1. Operating range 0 to 50 psig, linear to DDC.
 - 2. Provide threadolet for mounting to pipe installed by others.
 - 3. Accuracy ± 1 percent of range.

2.09 THERMOSTATS

- A. Electric Room Thermostats:
 - 1. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
 - 2. Service: Cooling only.
 - 3. Covers: Locking with set point adjustment, with thermometer.
- B. Low-Limit Temperature Cutout Switch (low-limit thermostat or freezestat):
 - 1. Configuration: Digital module tied to sensor-assembly.
 - 2. Sensing Length: As required to provide 1 foot of sensing element for each square foot of coil area.
 - 3. Setpoint Adjust: Slider.
 - 4. Switch Type: SPDT, snap-action, form C in dust-protected enclosure.
 - 5. Sensing Range: 15 to 55 degrees F.
 - 6. Mounting: Locate on as indicated on drawings, cooling coil intake side, or pre-heating/heating coil intake side.
 - 7. Field Interface: Connect load line-voltage to starter.
 - 8. Electrical Rating: Pilot duty, 125 VA at 125 to 600 VAC.
- C. Line Voltage Thermostats:
 - 1. Integral manual On/Off/Auto selector switch, single or two pole as required.
 - 2. Dead Band: Maximum 2 degrees F.
 - 3. Cover: Locking with set point adjustment, with thermometer.
 - 4. Rating: Motor load.
- D. Room Thermostat Accessories:
 - 1. Thermostat Covers: Brushed aluminum.
 - 2. Insulating Bases: For thermostats located on exterior walls.
 - 3. Thermostat Guards: Locking transparent plastic mounted on separate base.
 - 4. Adjusting Key: As required for device.
 - 5. Aspirating Boxes: Where indicated for thermostats requiring flush installation.
- E. Outdoor Reset Thermostats:
 - 1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
 - 2. Scale range: Minus 10 to 70 degrees F.
- F. Immersion Thermostats:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- G. Airstream Thermostats:

1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 2. Averaging service remote bulb element: 20 feet.
- H. Electric Low Limit Duct Thermostats:
1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint,
 2. Bulb length: Minimum 20 feet.
 3. Provide one thermostat for every 20 sq ft of coil surface.
- I. Electric High Limit Duct Thermostats:
1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above setpoint,
 2. Bulb length: Minimum 20 feet.
 3. Provide one thermostat for every 20 sq ft of coil surface.
- J. Fire Thermostats:
1. UL labeled, factory set in accordance with NFPA 90A.
 2. Normally closed contacts, manual reset.
- K. Heating/Cooling Valve Top Thermostats:
1. Proportional acting for proportional flow, molded rubber diaphragm, remote bulb liquid filled element, direct and reverse acting at differential pressure to 25 psig, cast housing with position indicator and adjusting knob.

2.10 TIME CLOCKS

- A. Seven day programming switch timer with synchronous timing motor and seven day dial, continuously charged Ni-cad battery driven power failure 8 hour carry over and multiple switch trippers to control systems for minimum of two and maximum of eight signals per day with two normally open and two normally closed output switches.
- B. Solid state programmable time control with ____ separate programs, 24 hour battery carry over, duty cycling.

2.11 TRANSMITTERS

- A. Building Static Pressure Transmitters:
1. One pipe, direct acting, double bell, scale range -0.10 to 0.10 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.
- B. Pressure Transmitters:
1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.
- C. Air Pressure Transmitters:
1. General: Provide dry media differential pressure transducers to monitor duct, room, and ____ pressure.
 - a. Media Compatibility: Dry air.
 - b. Pressure Ranges: 0 to 5 inch wg.
 - c. Response Time: 1 second.
 - d. Mode: Switch selectable, unidirectional.
 - e. Display:
 - 1) Signed 3-1/2 digit LCD, indicates pressure.
 - 2) Over-range indicator.
 - f. Proof Pressure (pressure differential): 3 psid.
 - g. Burst Pressure (pressure differential): 5 psid.
 - h. Accuracy: Plus/minus 1 percent f.s. (full scale) of selected range (combined linearity & hysteresis).

- D. Water Pressure Transmitters (Liquid Differential Pressure Transmitters):
1. General: Provide wet media differential pressure transducers with 6 ft (1.83 m) armored cable, to allow remote pressure sensing capability using existing plumbing runs.
 - a. Sensor:
 - 1) Media Compatibility: 17 to 4 PH stainless steel.
 - 2) Status Indication: Dual color LED.
 - 3) Proof Pressure: 2x max. F.S. range.
 - 4) Burst Pressure: 5x max. F.S. range.
 - 5) Accuracy at 77 degrees F for less than or equal 20 ft:
 - (a) Ranges A and B: Plus/minus 1 percent F.S. typical.
 - (b) Range C: Plus/minus 1.5 percent F.S. typical.
 - (c) Range D: Plus/minus 2 percent F.S. typical.
 - 6) Surge Damping: Electronic; 1 second averaging.
 - 7) Long Term Stability: Plus/minus 0.25 percent.
 - 8) Zero Offset (Bidirectional and Port Swap Modes Only): 0.5 percent.
 - b. Reverser:
 - 1) Zero Adjust: Push button auto-zero and digital input (2-position terminal block).
 - 2) Fittings:
 - (a) 27 NPT female thread, stainless steel 17 to 4 PH.
 - (b) Overall Thread Length: ___ inches complying with ASME B1.20.1.
 - c. Pressure Ranges:
 - 1) 0 psi to 50 psi (Gauge): 5 psid/10 psid/25 psid/50 psid (pressure differential).
 - 2) 0 psi to 100 psi (Gauge): 10 psid/20 psid/50 psid/100 psid (pressure differential).
 - 3) 0 psi to 250 psi (Gauge): 25 psid/50 psid/125 psid/250 psid (pressure differential).
 - d. Operating Conditions:
 - 1) Temperature Compensated Range:
 - (a) 32 degrees F.
 - (b) TC Zero less than 1.5 percent of product F.S. (full scale) per sensor.
 - (c) TC Span less than 1.5 percent of product F.S. (full scale) per sensor.
 - 2) Sensor Operating Range: Minus 4 degrees F to 185 degrees F.
 - 3) Operating Environment: 14 degrees F to 122 degrees F; 10 to 90 percent RH noncondensing.
 - e. Enclosure: NEMA 250, Type 4.
 - E. Temperature Transmitters:
 1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degrees F span and plus or minus 1 percent for 50 degrees F span, with 50 degrees F. temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.
 - F. Humidity Transmitters:
 1. One pipe, directly proportioned output signal to measured variable, linearity within plus or minus 1 percent for 70 percent relative humidity span, capable of withstanding 95 percent relative humidity without loss of calibration.

2.12 FLOW SENSORS

- A. Airflow Stations:
1. Air Flow Station (Duct Mounted):
 - a. Manufacturers:
 - 1) Ebtron
 - 2) Kurz

- b. General: Electronic air measuring system consisting of thermistor based sensor grid and microprocessor based electronics.
 - c. Sensor Probes: Thermistors probes and linear ICs, aluminum casing, duct mounted, wiring Teflon or kynar coated and encased, 20 degrees F to 160 degrees F operating range, weather resistant finish, flanged welded aluminum frame.
 - d. Microprocessor and Electronics: Solid state microprocessor, permanent non-volatile memory, regulated power supply, software based system, 0-5 vdc, 0-10 vdc, or 4-20 mA signals, linear flow and temperature outputs, line surge and transient protection.
 - e. Performance: ± 2 percent, +20 fpm across total calibrated range of 0 to 5000 fpm, for duct mounted, 0-10,000 fpm for fan inlet mounted, repeatability better than ± 0.4 percent of reading. Pressure drop not to exceed 0.005 inch W.G. at 2000 fpm.
 - f. Based On: Ebtron-Duct mounted XP000 series.
2. Air Flow Station (Fan Inlet):
- a. Manufacturers:
 - 1) Ebtron
 - 2) Air Monitor
 - 3) Paragon
 - 4) Pace
 - 5) Or equal.
 - b. Fan inlet airflow traverse probe, multiple total and static pressure sensors place at concentric area centers along exterior surface of cylindrical probe, internally connected to averaging manifolds.
 - c. Dual end support swivel brackets suitable for mounting in fan inlet bell, aluminum construction, hard anodized finish.
 - d. Probes capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors with an accuracy of 3 percent of actual flow over a fan operating range of 6 to 1 capacity turndown.
 - e. Based On: Fan Inlet XF000 series.
3. Automatic Air Flow Station Measuring Damper:
- a. Manufacturers:
 - 1) Ruskin IAQ50X
 - 2) Greenheck AMD-42
 - 3) Tamco/Ebtron Air-IQ
 - b. Description: Automatic control damper with integral electronic airflow measuring system.
 - c. Dampers:
 - 1) Multi-blade, airfoil type, extruded aluminum.
 - 2) Full-length axle shafts.
 - 3) Damper blades operate in unison.
 - 4) Dampers exceeding 25 SF in area two or more sections.
 - 5) Assembled depth not to exceed 18-inches.
 - 6) Leakage rating not to exceed 4 cfm/sf at 1-inch static pressure when tested in accordance with AMCA Standard 500D.
 - d. Damper Actuator:
 - 1) 24 VAC electric modulating.
 - e. Air Flow Measurement Assembly: Includes airflow measuring station, controller, and associated tubing and connections.
 - 1) Measuring Range: 300 fpm to 2,000 fpm velocity.
 - 2) Accuracy: ± 5 percent of reading.
 - 3) Solid state microprocessor.

- 4) Linear flow output.
 - 5) Line surge and transient protection.
 - 6) Input Signal: 0-10 VDC.
 - 7) Output Signal: 0-10 VDC.
- B. Ultrasonic Flow Meters:
1. Provide ultrasonic flow meters complete with matched transducers, self aligning installation hardware, and transducer cables.
 2. Optimize ultrasonic transducers for the specific pipe and process conditions for the application.
 3. Flow Meter Accuracy: Plus/minus 1 percent of rate from 0.98 fps to 40 fps.
 4. Include dry contact outputs, 4 to 20 mA, 0 to 10 VDC.
- C. Insertion Turbine Flow Meters:
1. Furnish dual axial turbine flowmeter with all installation hardware required to enable insertion and removal of the meter without system shutdown.
 2. All Parts: Meet or exceed the pressure classification of the piping system installed in.
 3. Accuracy for the Insertion Turbine Flow Meter: Plus/minus 0.5 percent of the rate at calibrated velocity, within plus/minus of the rate over a 10 to 1 turn down and within plus/minus 2 percent of the rate over a 50 to 1 turn down.
 4. Repeatability: Plus/minus 0.25 percent of reading.
 5. The meter flow sensing element to operate over a range suitable for the installed location with a pressure loss limited to 1 percent of operating pressure at maximum flow rate.
 6. Include dry contact outputs, 4 to 20 mA, 0 to 10 VDC.
 7. Fabricate the turbine rotor assembly of Series 300 stainless steel and use Teflon seats.
- D. Insertion Magnetic Flow Meters:
1. Provide insertion type magnetic flow meters with all installation hardware necessary to enable the insertion and removal of the meter without system shutdown.
 2. All Parts: Meet or exceed the pressure classification of the piping system installed in.
 3. Accuracy: No greater than 1 percent of the rate from 2 fps to 20 fps.
 4. Fabricate wetted material parts from 300 series stainless steel.
 5. Include 4 to 20 mA dry contact pulse outputs, 0 to 10 VDC.
- E. Vortex Shedding Flow Meters:
1. Accuracy: Within plus/minus 0.8 percent of the actual reading over the range of the meter.
 2. Steam meters to contain density compensation by direct measurement of temperature.
 3. Mass flow inferred from specified steam pressure will not be acceptable.
 4. Fabricate body from austenitic stainless steel and include a NEMA 250, weather tight Type 4X electronics enclosure.
 5. Design of the flowmeter body to not require removal from the piping in order to replace the shedding sensor.
- F. Positive Displacement Flow Meters:
1. Provide a direct reading, gerotor, nutating disc, vane type displacement device, or _____ rated for liquid service as indicated.
 2. A counter must be mounted on top of the meter and consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading.
 3. Provide totalizer with six digit register to indicate the volume passed through the meter in gallons, and a sweep-hand dial with indication down to 0.25 gallons.
 4. Equip the pulse transmitter with a hermetically sealed reed switch, activated by magnets fixed on gears of the counter.
 5. Meter: Bronze body with threaded, flanged, or _____ connection as required for the application.
 6. Output Accuracy: Plus/minus 2 percent of the flow range.

7. Maximum Pressure Drop: 5 psi.
- G. Gas Flow Meters:
 1. Furnish diaphragm or bellows type, gas positive displacement meters, for flows up to 2500 Std cu ft per hour, designed specifically for natural gas supply metering, and rated for the temperature, pressure, and flow rates of the installation.
 2. Minimum Turndown Ratio: 10 to 1 with an accuracy of plus/minus 1 of actual flow rate.
 3. Provide meter index with direct reading mechanical totalizing register and impulse dry contact output for remote monitoring.
 4. Electrical Impulse Dry Contact:
 - a. Field adjustment or calibration not required.
 - b. Output: Minimum resolution of 100 cu ft of gas per pulse not to exceed 15 pulses per sec at the design flow.
- H. Flow Switches:
 1. Repetitive Accuracy: Plus/minus 10 percent of actual flow setting.
 2. Switch Actuation: Adjustable over the operating range and sized for the application, such that the setpoint is between 25 and 75 percent of the full range.
 3. Provide Form C snap-action contacts, rated for the application.
 4. Furnish non-flexible paddle with magnetically actuated contacts, rated for service at a pressure greater than the installed conditions.
 5. Flow Switch for Use in Sewage Systems: Rated for use in corrosive environments encountered.

2.13 PRODUCTS OF COMBUSTION DETECTORS

- A. Duct smoke detectors are provided under division 28 - Electronic Safety and Security.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.
- G. Verify electrical metering equipment is connected to the Building Management System (BMS) and/or BMS network and communicating.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Room Thermostats and Room Sensors:
 1. Wall Thermostats and Room Sensors with User Adjustment: Mount at height of 42-inches above finished floor.
 2. Wall Thermostats and Room Sensors without User Adjustment: Mount at height of 60 inches above finished floor.
 3. Provide insulating back on thermostats mounted on exterior walls.
 4. Provide one thermostat for each zone of temperature control.
 5. Submit proposed locations for approval prior to preparing control drawings, where not shown or alternate location is proposed.
- C. Carbon Dioxide Sensor:
 1. Mount sensor at 5 feet above finished floor or as indicated on the plans.

2. Provide sensor quantity as indicated on plans or as required by sensor coverage rating (maximum 20-foot radius).
 3. Alarm above 850 ppm.
 4. Refer to sequence of operations for more information on sensor use.
- D. Window Switch:
1. Installation of window switches in accordance with window manufacturer's requirements and not to void window warranty.
 2. Provide necessary components for a complete installation.
 3. Coordinate with window manufacturer for factory or field installation of components.
 4. Align magnet with proximity switch.
 5. Coordinate installation with Architect and other trades.
- E. Mount freeze protection thermostats using flanges and element holders.
- F. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- G. Provide separable sockets for liquids and flanges for air bulb elements.
- H. Provide thermostats in aspirating boxes in front entrances.
- I. Provide guards on thermostats in entrances.
- J. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- K. Provide separate steam valves for each bank of coils. Provide two valves in parallel where steam load exceeds 1500 lb per hr with 1/3 to 2/3 load capacities sequenced with smaller valve opening first.
- L. Provide mixing dampers of parallel blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors. Provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.
- M. Provide isolation (two position) dampers of parallel blade construction.
- N. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- O. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- P. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- Q. Provide conduit and electrical wiring in accordance with Section 26 0583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.03 MAINTENANCE

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- D. Provide complete service of controls systems, including call backs, and submit written report of each service call.
- E. In addition to normal service calls, make minimum of 8 complete normal inspections of approximately 8 hours duration to inspect, calibrate, and adjust controls.

END OF SECTION 23 0913

**SECTION 23 0923
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. System description.
- B. Connection to existing network.
- C. Operator interface.
- D. Controllers.
- E. Input/Output interface.
- F. Power supplies and line filtering.
- G. Uninterruptible power supply (UPS).
- H. Local area network (LAN).
- I. System software.
- J. Controller software.
- K. HVAC control programs.
- L. Energy management system.

1.02 RELATED REQUIREMENTS

- A. Section 23 0913 - Instrumentation and Control Devices for HVAC.
- B. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
- C. Section 28 4600 - Fire Detection and Alarm.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks.
- B. ASHRAE Std 147 - Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems.
- C. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests.
- D. NFPA 70 - National Electrical Code.
- E. UL (DIR) - Online Certifications Directory.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide data for each system component and software module.
- C. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. List connected data points, including connected control unit and input device.
 - 3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
 - 4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 5. Indicate description and sequence of operation of operating, user, and application software.
- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

- E. Designer's Qualification Statement.
- F. Manufacturer's Qualification Statement.
- G. Installer's Qualification Statement.
- H. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Include submittals data in final "Record Documents" form.
- I. Software Data:
 - 1. Submittals consist of complete descriptions of system, command, and applications software as specified.
 - 2. Include description of control sequences which are software based using detailed logic flow diagrams.
 - 3. Diagrams indicate logic used to achieve control sequence of calculation specified, and show relationship between control sequence and application software packages specified.
- J. Testing Submittals:
 - 1. Provide test plan and test procedures for approval.
 - 2. Explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of this specification and methods for simulating necessary conditions of operation to demonstrate performance of the system.
 - 3. Test plan and test procedures demonstrate capability of system to monitor and control equipment and to accomplish control and monitoring specified.
- K. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 4. Hardware Manual: Furnish a hardware manual describing equipment provided, including:
 - a. General description and specifications.
 - b. Installation and checkout procedures.
 - c. Equipment electrical schematics and layout drawings.
 - d. System schematics and I-O wiring lists.
 - e. Alignment and calibration procedures.
 - 5. Software Manual:
 - a. Describe furnished software.
 - b. Oriented to programmers and describe calling requirements, data exchange requirements, data file requirements and other information necessary to enable proper integration, loading, testing, and program execution.
 - c. Provide one software manual per Operator's Terminal.
 - 6. Operator's Manual: Provide procedures and instructions for operation of the system, including:
 - a. DDC Panels and Peripherals
 - b. System start-up and shutdown procedures.
 - c. Use of system, command, and applications software.
 - d. Alarm Presentation
 - e. Recovery and Restart Procedures
 - f. Report Generation
 - g. System Schematic Graphics
 - h. Provide one Operator's Manual per Operator's Terminal

7. Maintenance Manual: Provide descriptions of maintenance for equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
8. Acceptance Test Forms: Maintenance manual includes copies of signed-off acceptance test forms.
- L. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 ACCEPTANCE TESTING AND TRAINING

- A. Site Testing:
 1. General: Provide personnel, equipment, instrumentation, and supplies necessary to perform testing. Owner or Owner's representative will witness and sign off on acceptance testing.
 2. Acceptance Test: Demonstrate compliance of completed control system with contract documents. Using approved test plan, physical and functional requirements of project demonstrated.
- B. Training:
 1. General:
 - a. Conduct training courses for designated personnel in operation and maintenance of system.
 - b. Oriented to specific system being installed under this contract.
 - c. Provide trainee with two additional copies provided for archival at project site.
 - d. Manuals include detailed description of the subject matter for each lesson.
 - e. Provide copies of audiovisuals to Owner.
 - f. Training day is defined as 8 hours of classroom instruction, including two, 15-minute breaks and excluding lunch time, Monday through Friday, during normal first shift in effect at training facility.
 - g. Notification of any planned training given to the Owner's representative at least 15 days prior to the training.
 2. Operator's Training I:
 - a. Teach first course at supplier's facility for period of two consecutive training days.
 - b. Upon completion, each student, using appropriate documentation, perform elementary operations with guidance and describe general hardware architecture and functionality of system.
 3. Operator's Training II:
 - a. Teach second course at project site for a period of one training day after completion of Contractor's field testing.
 - b. Include instruction on specific hardware configuration of installed system and specific instructions for operating the installed system.
 - c. Upon completion, each student able to start system, operate the system, recover the system after failure, and describe the specific hardware architecture and operation of system.
 4. Operator's Training III:
 - a. Teach third course at project site for period of one training day no later than six months after completion of the acceptance test.
 - b. Structure course to address specific topics that students need to discuss and to answer questions concerning operation of system.
 - c. Upon completion, students fully proficient in system operation and have no unanswered questions regarding operation of installed system.

1.07 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.
- D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.
- E. Provide work by single company with specialists in the type of work required, so that only one control manufacturer is responsible for control and automation work for project.
- F. Provide coordination with other contractors or subcontractors for work required by other trades for accomplishment of control work.
- G. Demonstrate to Owner that system is operating per the Specifications and final adjustments have been made as approved prior to substantial completion.
- H. System, including components and appurtenances, configured and installed to yield a Mean Time Between Failure (MTBF) of at least 1,000 hours.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. General:
 - 1. Provide a complete control system, consisting primarily of electronic direct digital control devices.
 - 2. System consists of modular and distributed microprocessor based control and monitoring units connected together by communications trunks. Capable of global data sharing and communication between controllers.
 - 3. System architecture distributed and not rely on central processing unit (CPU) for sharing point data between controllers, or for control functions requiring data from other controllers.
 - 4. Multipurpose controller(s) consisting of CPU, system program, memory, power supply, and input/output drivers which communicated with terminal equipment controllers through a communications network.
 - 5. Provide operator's interface.
 - 6. Provide equipment, installation, wiring, and accessories as required but not necessarily specified to accomplish operations as described.
- B. Environmental Conditions:
 - 1. Rate DDC panels and other field equipment for continuous operation under ambient environmental conditions of 35 degrees F to 120 degrees F dry bulb and 10 percent to 95 percent relative humidity, noncondensing.
 - 2. Instrumentation and control elements rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installation.
 - 3. Install control devices in an enclosure suitable for the installed environment.
- C. System Accuracy and Display:
 - 1. Space Temperature:
 - a. Conditioned Spaces: Within range of 50 degrees F to 85 degrees F \pm 1 degrees F (display to nearest 0.5 degrees F).

- b. Undonditioned Spaces: Within range of 15 degrees F to 130 degrees F \pm 1 degrees F (display to nearest 0.5 degrees F).
- 2. Duct temperature with a range of 40 degrees F to 140 degrees F \pm 1 degrees F (display to nearest 0.5 degrees F).
- 3. Water Temperature:
 - a. Within range of 30 degrees F to 100 degrees F \pm 1 degrees F (display to nearest 0.5 degrees F).
 - b. Within range of 100 degrees F to 300 degrees F \pm 2 degrees F (display to nearest 0.5 degrees F).
- 4. Water temperatures for the purpose of performing BTU calculations using differential temperatures to \pm 0.5 degrees F using matched sensors (display to nearest 0.5 degrees F).
- 5. Pressure with a range for the specific application \pm 5 percent of range.

2.02 CONNECTION TO EXISTING NETWORK

- A. General: Communication between peer-to-peer DDC control panels via TCP/IP over the existing Ethernet system.
- B. Provide software and system integration to seamlessly integrate to the existing server for common system graphics, alarming, paging out of alarms via existing paging systems.

2.03 OPERATOR INTERFACE

- A. PC Based Work Station:
 - 1. Resides on high speed network with building controllers.
 - 2. Connected to server for full access to all system information.
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
- C. BACnet protocol to comply with ASHRAE Std 135.
- D. Hardware:
 - 1. Desktop:
 - a. Computer(s) and display(s) to be provided by DDC controls manufacturer.
 - b. Quantity: As indicated on the drawings.
 - c. Minimum RAM: 512 MB.
 - d. Minimum Processing Speed: 2.8 GHz.
 - e. Monitor: Minimum 17-inch (nominal) flat screen color monitor, supporting a minimum display resolution of 1280x1024 pixels, with separate controls for color contrast and brightness, and non-reflective screen..
 - f. Location(s): As indicated on the drawings.
 - g. Network Connection:
 - 1) Ethernet interface card.
 - 2) Minimum Speed: _____.
 - h. System Printer:
 - 1) Printer(s) to be provided by DDC controls manufacturer.
 - 2) Quantity: As indicated on the drawings.
 - 3) Type: _____.
 - 4) Resolution: _____.
 - 5) Minimum Print Speed: _____.
 - 6) Locations(s): As indicated on the drawings.
 - 2. Web-Based Access:
 - a. Provide a web-based controls interface with at least three user login accounts and password each with the capability of different access privileges that performs data access, operator's commands, alarm notification, requests for reports, file generation, diagnostics, and modifications.

- b. Controls accessible in mechanical room by direct connection from a laptop to a data port.
 - c. Provide a temporary computer located on-site in the mechanical room until the commissioning, testing, and balancing has been completed.
 - d. Provide a temporary computer located on-site in the mechanical room, with software and capabilities necessary to support commissioning, testing, and balancing and other activities required for project completion.
3. Graphics: Provide a complete graphics package with the following features:
- a. Provide separate schematic diagram depicting each system. Diagrams to show major components such as fans, dampers, heating and cooling coils, humidifiers, pumps, heat exchangers, chillers, boilers, towers, ductwork, piping, etc., arranged to convey to viewer system configuration and flow of each system.
 - b. Provide plot plan, riser plan, and selected floor plans of buildings with the location of each mechanical room and major equipment location indicated.
 - c. Provide symbols superimposed on each schematic to indicate each control device including control valves, damper motors, temperature sensors, pressure sensors, etc. Provide real time dynamic displays of the temperature, humidity, pressure, flow rate, run status, alarm status, and etc., adjacent to each control symbol. Arrange CPU to update each displayed analog and digital value minimum of every 15 seconds.
 - d. Provide indication of setpoints, with each setpoint value located adjacent to each sensed value.
 - e. Provide means to allow the user to easily change or add graphics via computer assisted drawing function utilizing freehand mouse.
 - f. Provide means to allow user to transfer repeated system schematics and symbols between graphics without redrawing them. Provide symbol library arranged to store commonly used symbols.
 - g. Provide a "telescoping" or "zoom" program to allow use to move from plot plan to mechanical room plan to system graphic to control device display by simply clicking the mouse.
 - h. Provide dual function windowing program to allow user to view a split screen and toggle between simultaneous operations.

2.04 CONTROLLERS

A. Building Controllers:

- 1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
- 2. Communication:

- a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- B. Custom Application Controller:
- 1. General:
 - a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - b. Share data between networked, microprocessor based controllers.
 - c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - d. Utilize real-time clock for scheduling.
 - e. Continuously check processor status and memory circuits for abnormal operation.
 - f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - g. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- C. Application Specific Controllers:
- 1. General:
 - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - b. Customized for operation within the confines of equipment served.
 - c. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- D. Input/Output Interface:
- 1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 - 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either digital or analog type with appropriate properties.
 - 3. Digital Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Comply with all requirements of digital input objects and accept up to 10 pulses per second.
5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
6. Digital Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
 - a. Coordinate two digital outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - 1) VAV terminal units.
 - 2) Duct mounted heating coils.
 - 3) Zone dampers.
 - 4) Radiation.
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.05 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies:
 1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
 2. Limit connected loads to 80 percent of rated capacity.
 3. Match DC power supply to current output and voltage requirements.
 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
 5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
 7. Operational Ambient Conditions: 32 to 120 degrees F.

8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
 9. Line voltage units UL recognized and CSA approved.
- B. Power Line Filtering:
1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
 2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.06 UNINTERRUPTIBLE POWER SUPPLY (UPS)

- A. General:
1. Provide an uninterruptible power supply (UPS) for each DDC field panel.
 2. Fed by 120V AC emergency power circuits.
 3. Floor or wall mountable.
- B. UPS:
1. Provide MGE Pulsar UPS or pre-bid approved equal.
 2. Products carry UL 1778 listing.
 3. Base sizing on peak current requirements of connected load plus 15 percent factor of safety.
 4. Provide manufacturer's standard three-year comprehensive warranty, including batteries.

2.07 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over dedicated local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.08 SYSTEM SOFTWARE

- A. Operating System:
1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 - b. Acceptable Operating Systems: _____.
 2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:

- (a) Analog and digital values.
 - (b) Dynamic text.
 - (c) Static text.
 - (d) Animation files.
- 3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.
 - c. Capture or convert graphics from AutoCAD.
- 4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - 1) Chillers.
 - 2) Boilers.
 - 3) Air Handlers.
 - 4) Terminal HVAC Units.
 - 5) Fan Coil Units.
 - 6) Unit Ventilators.
 - b. Ancillary Equipment:
 - 1) Fans.
 - 2) Pumps.
 - 3) Coils.
 - 4) Valves.
 - 5) Piping.
 - 6) Dampers.
 - 7) Ductwork.
 - c. File Format Compatible with Graphics Generation Package Program.
- B. Workstation System Applications:
 - 1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
 - 2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
 - 3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
 - 4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
 - 5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.

- e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
- f. All system security data stored in encrypted format.
- 6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
 - 3) Modems.
 - 4) Network connections.
 - 5) Building management panels.
 - 6) Controllers.
 - b. Device failure is annunciated to the operator.
- 7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
- 8. Alarm Messages:
 - a. Descriptor: English language.
 - b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
- 9. Configurable Alarm Reactions by Workstation and Time of Day:
 - a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics.
- 10. Custom Trend Logs:
 - a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - 1) Sampled and stored on the building controller panel.
 - 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
- 11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
- 12. Object, Property Status and Control:

- a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
13. Reports and Logs:
- a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - 3) Archivable to hard disk.
 - b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
 - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - d. Set to be printed on operator command or specific time(s).
14. Reports:
- a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:
 - (a) Alarm History.
 - (b) System messages.
 - (c) System events.
 - (d) Trends.
 - b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
 - c. Tenant Override:
 - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
 - d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - (a) Monthly showing daily natural gas consumption for each meter.
 - (b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:

- (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
- e. Daily Operating Condition of Chiller(s) Based on ASHRAE Std 147:
 - 1) Chilled water inlet and outlet temperature.
 - 2) Chilled water flow.
 - 3) Chilled water inlet and outlet pressure.
 - 4) Evaporator refrigerant pressure and temperature.
 - 5) Condenser refrigerant pressure and temperature.
 - 6) Condenser refrigerant pressure and liquid temperature.
 - 7) Condenser water flow.
 - 8) Refrigerant levels.
 - 9) Oil pressure and temperature.
 - 10) Oil level.
 - 11) Compressor refrigerant discharge temperature.
 - 12) Refrigerant suction temperature.
 - 13) Addition of refrigerant.
 - 14) Addition of oil.
 - 15) Vibration levels or observation that vibration is not excessive.
 - 16) Motor amperes per phase.
 - 17) Motor volts per phase.
 - 18) PPM refrigerant monitor level.
 - 19) Purge exhaust time or discharge count.
 - 20) Ambient temperature (dry-bulb and wet-bulb).
 - 21) Date and time logged.
- C. Workstation Applications Editors:
 - 1. Provide editing software for each system application at PC workstation.
 - 2. Downloaded application is executed at controller panel.
 - 3. Full screen editor for each application allows operator to view and change:
 - a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
 - 4. Scheduling:
 - a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.
 - 5. Custom Application Programming:
 - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.

- 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
- 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
- 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.09 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 1. User access secured via user passwords and user names.
 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 3. User Log On/Log Off attempts are recorded.
 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
 2. Exception Schedules:
 - a. Based on any day of the year.
 - b. Defined up to one year in advance.
 - c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
 3. Holiday or Special Schedules:
 - a. Capability to define up to 99 schedules.
 - b. Repeated annually.
 - c. Length of each period is operator defined.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:
 1. Digital object is set to alarm based on the operator specified state.
 2. Analog object to have high/low alarm limits.
 3. All alarming is capable of being automatically and manually disabled.
 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
 - 1) Start programs.
 - 2) Print.
 - 3) Logged.

- 4) Custom messaging.
 - 5) Graphical displays.
 - 6) Dial out to workstation receivers via system protocol.
- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
 - G. Sequencing: Application software based upon specified sequences of operation.
 - H. PID Control Characteristics:
 - 1. Direct or reverse action.
 - 2. Anti-windup.
 - 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 - 4. User selectable controlled variable, set-point, and PED gains.
 - I. Staggered Start Application:
 - 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 - 2. Order of equipment startup is user selectable.
 - J. Energy Calculations:
 - 1. Accumulated instantaneous power or flow rates are converted to energy use data.
 - 2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
 - 3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
 - K. Anti-Short Cycling:
 - 1. All digital output objects protected from short-cycling.
 - 2. Allows minimum on-time and off-time to be selected.
 - L. On-Off Control with Differential:
 - 1. Algorithm allows digital output to be cycled based on a controlled variable and set-point.
 - 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
 - M. Run-Time Totalization:
 - 1. Totalize run-times for all digital input objects.
 - 2. Provides operator with capability to assign high run-time alarm.

2.10 HVAC CONTROL PROGRAMS

- A. General:
 - 1. Support Inch-pounds and SI (metric) units of measurement.
 - 2. Identify each HVAC Control system.
- B. Optimal Run Time:
 - 1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
 - 2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
 - 3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
 - 4. Use outside air temperature to determine early shut down with ventilation override.
 - 5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
 - 6. Operator commands:
 - a. Define term schedule.
 - b. Add/delete fan status point.
 - c. Add/delete outside air temperature point.
 - d. Add/delete mass temperature point.

- e. Define heating/cooling parameters.
 - f. Define mass sensor heating/cooling parameters.
 - g. Lock/unlock program.
 - h. Request optimal run time control summary.
 - i. Request optimal run time mass temperature summary.
 - j. Request HVAC point summary.
 - k. Request HVAC saving profile summary.
7. Control Summary:
- a. HVAC Control system begin/end status.
 - b. Optimal run time lock/unlock control status.
 - c. Heating/cooling mode status.
 - d. Optimal run time schedule.
 - e. Start/Stop times.
 - f. Selected mass temperature point ID.
 - g. Optimal run time system normal start times.
 - h. Occupancy and vacancy times.
 - i. Optimal run time system heating/cooling mode parameters.
8. Mass temperature summary:
- a. Mass temperature point type and ID.
 - b. Desired and current mass temperature values.
 - c. Calculated warm-up/cool-down time for each mass temperature.
 - d. Heating/cooling season limits.
 - e. Break point temperature for cooling mode analysis.
9. HVAC point summary:
- a. Control system identifier and status.
 - b. Point ID and status.
 - c. Outside air temperature point ID and status.
 - d. Mass temperature point ID and point.
 - e. Calculated optimal start and stop times.
 - f. Period start.

2.11 ENERGY MANAGEMENT SYSTEM

- A. General:
- 1. Provide a complete system consisting of metering instruments, communications between components; communications network; data loggers; protocol converters and other appurtenances as required for a complete system.
 - 2. Provide meters, network controllers, and Ethernet gateways with non-volatile flash memory sufficient to maintain system programming indefinitely.
- B. Data Acquisition Network:
- 1. Connect meters to DDC system via TCP/IP communications over Ethernet LAN. Communications in BACnet/IP protocol.
 - 2. The system may utilize Modbus for communication with field devices over local RS-485 communications links.
 - 3. Connection to the building Ethernet network made at the nearest wall data outlet in a mechanical or electrical room.
 - 4. Limit cabling lengths between devices in accordance with manufacturers published requirements.
- C. Data Access and Display:

1. Measured values, both instantaneous readings and historical data, available to users on any computer with an Internet connection without requiring a specific operating system or proprietary software that is not publically available freeware.
 2. Assign each metering a unique network address and by entering that address or corresponding URL into a web browser, HTML web pages of data available for that device.
 3. Specific browser software permitted to be required to access system features beyond the measured values.
- D. Data Format:
1. The complete system synchronizes to a single time base so that events on the system can be compared at different locations on the system using a common time base. Time base synchronized with DDC system.
 2. Data stored in DDC system database.
- E. Software:
1. Seamless BACnet/IP integrated with building Direct Digital Control, DDC system, and have the ability to display individual meter output data.
 2. Calculation engine to virtually calculate, display, and store-derived values.
 3. Minimum download meter data every 15 minutes.
- F. Interface and Display:
1. Provide 32-inch LED flat panel display.
 2. Scroll through display features in 20 second intervals (adjustable).
 3. Display:
 - a. Monthly Utility Total Energy (kbtu) and EUI (kbtu/sf/yr) bar chart overlaid with the prior year by month. Use different colors to indicate the contribution of gas and electricity to each monthly total bar.
 - b. Monthly System Total Energy (kbtu) and EUI (kbtu/sf/yr) bar chart overlaid with the prior year by month. Use different colors to indicate the contribution of each end use (Mechanical, plug loads, plumbing, and lighting) to each monthly total bar.
 - c. Current Day's end use energy demand (kW) overlaid with the annual weekday and weekend average demand (kW), and temperature in a line chart. Provide separate slides for Lighting and Plug Load end uses.
 - d. Current Day's end use energy demand (kbtu/hr) overlaid with the annual weekday and weekend average demand (kbtu/hr), and temperature in a line chart. Provide separate slides for Mechanical and Plumbing Load end uses.
 - e. Energy Meter Gauge indicating real-time end use energy demand (kW and W/sf) for Lighting and Plug Loads.
 - f. Energy use pie chart indicating percent of annual energy from each enduses (Mechanical, Plumbing, Plug Loads and Lighting).
 - g. Monthly water usage (gallons) and WUI (gallons/person/year) bar chart overlaid with the prior year by month.
- G. Current Sensors and Transformers:
1. Current Transformers, 5 A:
 - a. Submetering:
 - 1) Accuracy: 1.0 percent (10 percent-100 percent of Current Transformer rating).
 - 2) Split-core: Flex-core, Hawkeye, Square-D, Veris.
 2. Current Sensors; 0-5 VDC, 330 milli-volt:
 - a. Submetering:
 - 1) Accuracy: 1.0 percent (10 percent-100 percent of Current Transformer rating).
 - 2) Manufacturers: Square-D, Magnelab, Veris, Sentron.
- H. Electrical Energy Meters:

1. Measured values: Real kWh, Reactive kVARh, apparent kVAh, kW, power factor, RMS power, and current per phase.
2. Voltage: monitored circuit voltage indicated in documents.
3. Current Transformers: Provide milli-volt compatible meters where milli-volt Current Transformers are used.
4. Minimum Current Transformer input amperage (5 Amp Current Transformer only): 10A.
5. Sampling rate: minimum 3 kHz.
6. Submetering Meter Accuracy: +/-1 percent accuracy (10 percent to 100 percent of Current Transformer rating).
7. Manufacturers: Veris E50, Siemens, Square D.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.
- C. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.
- D. Provide conduit and electrical wiring in accordance with Section 26 0583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.
- E. Provide control wiring for control devices and control panels.
- F. Run control wiring in mechanical rooms or locations susceptible to damage in conduit. Plenum rated cable may be used in other locations .
- G. Provide power wiring for control devices and control panels. Utilize designated circuits in electrical power panels. Refer to Electrical Drawings. If no circuits are designated for DDC Controls, submit detailed request for use of spare circuits at no additional cost.
- H. Install power wiring in conduit.
- I. Grounding: Instrumentation and communication grounding installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
- J. Control voltage limited to maximum of 120V.
- K. Where relay coil is connected to load side of motor starter to energize with motor operation, external control circuit properly fused with fuse block located in respective starter enclosure.
- L. Where relays are used to control single-phase motors directly, provide contacts rated for not less than horsepower rating of largest motor switched by relay.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.
- C. Provide basic operator training for _____ persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.04 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Owner.

3.05 MAINTENANCE

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.
- C. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- D. Provide complete service of systems, including call backs. Make minimum of ____ complete normal inspections of approximately ____ hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

END OF SECTION 23 0923

**SECTION 23 2113
HYDRONIC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Equipment drains and overflows.
- D. Unions, flanges, mechanical couplings, and dielectric connections.
- E. Solder and braze.
- F. Pipe wrapping.

1.02 RELATED REQUIREMENTS

- A. Section 23 0516 - Expansion Fittings and Loops for HVAC Piping.
- B. Section 23 0523 - General-Duty Valves for HVAC Piping.
- C. Section 23 0529 - Hangers and Supports for HVAC Piping and Equipment.
- D. Section 23 0553 - Identification for HVAC Piping and Equipment.
- E. Section 23 0719 - HVAC Piping Insulation.
- F. Section 23 2114 - Hydronic Specialties.
- G. Section 23 2500 - HVAC Water Treatment.
- H. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- B. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- F. ASME B31.9 - Building Services Piping.
- G. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
- H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- I. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
- J. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
- K. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- L. ASTM A536 - Standard Specification for Ductile Iron Castings.
- M. ASTM B32 - Standard Specification for Solder Metal.
- N. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- O. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- P. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
- Q. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- R. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- S. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- T. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- U. AWWA C606 - Grooved and Shouldered Joints.

- V. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 3. Indicate valve data and ratings.
 - 4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E. Project Record Documents: Record actual locations of valves.
- F. Treatment Reports.
- G. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.
- H. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum three years of experience.
- C. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- D. Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.
- E. Coupling Manufacturer:
 - 1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 - 2. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
 - 3. A distributor's representative is not considered qualified to perform the training.
- F. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
 - 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.
- G. Piping material and installation to meet requirements of the local building codes and serving utility requirements.
- H. Pipe cleaning: Should any pipe be plugged or should foaming of water systems occur, disconnect piping, re-clean, and reconnect without additional expense to the Owner.
- I. Correct damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Copper tube joints:
 - a. Copper Tube Sizes 1-1/2 inch and below: Soldered.
 - b. Copper Tube Sizes 2 inch and above: Brazed.
 - 4. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
 - b. Grooved mechanical connections and joints comply with AWWA C606.
 - 1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
 - 2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
 - c. Use rigid joints unless otherwise indicated.
 - d. Use flexible joints where indicated.
 - e. Depending on pipe size, three or four flexible joints may be used in lieu of a flexible connector.
 - f. Use gaskets of molded synthetic rubber with central cavity, pressure-responsive configuration, and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
 - g. Provide steel coupling nuts and bolts complying with ASTM A183.
 - 5. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges or unions to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:
 - 1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
 - 2. On discharge of pumps, use spring loaded check valves.
 - 3. For throttling, bypass, or manual flow control services, use globe valves.
 - 4. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.02 HEATING WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
 - 1. Fittings: ASTM A234/A234M, wrought steel welding type. Short radius elbows not acceptable for use except as approved on a case by case basis.

2. Joints:
 - a. Welded: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - b. Threaded: ASME B16.3, malleable iron fittings.
 - c. Grooved: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Steel Pipe Sizes 12 Inch and Greater: ASTM A53/A53M, 3/8 inch wall, black.
 1. Fittings: ASTM A234/A234M, wrought steel welding type. Short radius elbows not acceptable for use except as approved on a case by case basis.
 2. Joints:
 - a. Welded: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - b. Threaded: ASME A536 ductile iron fittings.
 - c. Grooved: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- C. Copper Tube Sizes 4 inch and below: ASTM B88 (ASTM B88M), Type L, hard drawn.
 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.

2.03 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L, hard drawn.
 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

2.04 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions:
 1. Ferrous Piping: 150 psig malleable iron, threaded, brass to iron seat, black or galvanized to match pipe.
 2. Copper Pipe: 200 psi WOG, bronze, soldered joints.
- B. Flanges for Pipe 2 Inches and Greater:
 1. Ferrous Piping: Cast iron or steel for screwed piping and forged steel welding neck for welded line sizes.
 2. Copper Piping: Bronze.
 3. Gaskets: 1/8 inch thick, non-metallic type, EPDM, Garlock 3700 or equal.
 4. Pressure Rating and Drilling: In accordance with ASME B16.1; 150 lb. for system pressures 150 psig to 400 psig. Match apparatus, valve, or fitting to which they are attached.
 5. Hardware: Make joint using American Standard hexagon head bolts, lock washers, and nuts (per ASTM A307 GR.B) for service pressures to 150 psig; alloy steel stud bolts, lock washer, and American Standard hexagon head nut (per ASTM A307 GR.B) for service pressures 150 psig to 400 psig. Use length of bolt required for full nut engagement. Provide electro-cad plated bolts and nuts on cold and chilled water lines.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 1. Dimensions and Testing: In accordance with AWWA C606.
 2. Mechanical Couplings: Comply with ASTM F1476.
 3. Housing Material: Ductile iron complying with ASTM A536, rust inhibiting paint.

4. Gasket Material: Grade E EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F, Flushseal, Installation Ready or Flush Gap configuration.
 5. Bolts and Nuts: ASTM A183, zinc-electroplated steel.
 6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 7. Manufacturers:
 - a. Apollo Valves.
 - b. Victaulic.
 - c. Anvil Gruvlock.
 - d. Grinnell Products, a Tyco Business.
 - e. Shurjoint Piping Products, Inc.
 - f. Victaulic Company.
 - g. Substitutions: See Section 01 6000 - Product Requirements.
- D. Dielectric Connections:
1. Waterways:
 - a. Nationally listed, have a dielectric thermoplastic interior lining, and meet requirements of ASTM F1545.
 - b. Suitable for the required operating pressures and temperatures.
 2. Flanges:
 - a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600-volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.

2.05 SOLDER AND BRAZE

- A. Brazed Joints:
1. Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.
 2. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
- B. Soldered Joints:
1. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
 2. Valves, Cast Fittings, or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.

2.06 PIPE WRAPPING

- A. Below ground steel piping and fittings, provide complete covering of Scotchrap 51, 20 mil thickness, protective tape applied over Scotchrap pipe primer applied at 1 gal/800 SF of pipe surface.
- B. Pipe may be furnished with factory applied jacket of X-tru-coat with Scotchrap as previously specified for field joints.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

- F. After completion, fill, clean, and treat systems. See Section 23 2500 for additional requirements.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME B31.9 requirements.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and to avoid interference with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls, and floors.
- G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified _____.
- H. Slope piping and arrange to drain at low points.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 23 0516.
 - 1. Use flexible couplings in expansion loops.
- J. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- K. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 - 2. Place hangers within 12 inches of each horizontal elbow.
 - 3. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 4. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 5. Provide copper plated hangers and supports for copper piping.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 0719.
- M. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100
- N. Use eccentric reducers to maintain top of pipe level.
- O. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- P. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. See Section 09 9123.
- Q. Install valves with stems upright or horizontal, not inverted.

END OF SECTION 23 2113

**SECTION 23 2114
HYDRONIC SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air vents.
- B. Air separators.
- C. Strainers.
- D. Pressure-temperature test plugs.
- E. Balancing valves.
- F. Relief valves.
- G. Pressure reducing valves.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2500 - HVAC Water Treatment.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- D. Project Record Documents: Record actual locations of flow meters.
- E. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 AIR VENTS

- A. Manufacturers:

1. Hoffman.
 2. Amtrol.
 3. Spirax-Sarco.
 4. Spirotherm.
 5. Dole.
 6. Peerless.
 7. Armstrong International, Inc.
 8. ITT Bell & Gossett.
 9. Nexus Valve, Inc.
 10. Taco, Inc.
- B. Manual Air Vent: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Air Vent:
1. Brass or steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- D. Automatic Type:
1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve, 150 psi operating pressure, 1/8-inch IPS top tapping, 3/4-inch size.
- E. Maximum Fluid Pressure: 150 psi.
- F. Maximum Fluid Temperature: 250 degrees F.

2.02 AIR SEPARATORS

- A. Coalescing Air/Dirt Separators:
1. Manufacturers:
 - a. Armstrong International, Inc.
 - b. ITT Bell & Gossett.
 - c. Spirotherm, Inc.
 - d. Caleffi.
 2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1; for 150 psi operating pressure and 270 degrees F maximum operating temperature; subject to the requirements of the application and the manufacturer's standard maximum operating conditions; removable head.
 3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location. Dirt separation efficiency of 80 percent of particles 30 micron and larger with 100 passes.
 4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to the top of the separator. Valved side tap to bleed large amounts of air during system fill.
 5. Blowdown Connection: Threaded.
 6. Maximum Fluid Service Pressure: 150 psi.
 7. Maximum Fluid Service Temperature: 250 degrees F.

2.03 STRAINERS

- A. Manufacturers:
1. NIBCO.
 2. Armstrong International, Inc.
 3. McAlear Manufacturing Co.
 4. Sarco, Inc.
 5. Steamflo.

6. Mueller.
 7. R.P. & C. Company.
 8. Titan Flow Control.
 9. Gruvlok.
 10. Victaulic.
- B. Wye Pattern:
1. Bronze: Bronze body, 250 psi.
 2. Ductile Iron: Ductile iron body, 300 psi.
 3. Cast Iron: Cast iron body, 125 psi.
 4. Cast Iron, High Pressure: Cast iron body, 250 psi.
- C. Basket Pattern: Semi-steel body, 125 psi WOG, flanged, closed bottom basket, clamped, or bolted cover.
- D. Screen:
1. Material: 304 stainless steel.
 2. Perforations:
 - a. General applications: 1/8-inch.
 - b. Upstream of heat exchangers, heat pumps, and chillers: 60-mesh (250 Micron).

2.04 PRESSURE-TEMPERATURE TEST PLUGS

- A. Manufacturers:
1. Universal Lancaster.
 2. Trerice.
 3. Peterson Equipment Company Inc.
 4. Sisco Manufacturing Company Inc.
- B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Nordel rated for minimum 300 psig at 275 degrees F.
- C. Application: Use extended length plugs to clear insulated piping.
- D. Gauges and Thermometers: Supply Owner with two pressure gauge adapters with 1/8-inch O.D. probe and two five-inch stem pocket test thermometers 25 degrees -125 degrees F for chilled water, 40 degrees -240 degrees F for heating water.

2.05 BALANCING VALVES

- A. Manufacturers:
1. DeZurik.
 2. Homestead.
 3. Bell and Gossett.
 4. Walworth.
 5. Taco.
 6. Wheatley.
 7. Tour & Andersson.
 8. Victaulic.
 9. Gruvlok.
 10. NIBCO.
 11. Armstrong International, Inc.
 12. Bell & Gossett, a brand of Xylem, Inc.
- B. Calibrated Bronze Globe Valve
1. Y-pattern globe style design. Precision flow measurement, precision flow balancing, memory stops, positive shut-off to a minimum of 250 psi, drain port suitable for hose bibb fitting. Threaded or solder ends for 1/2-inch through 2-inches. 1/2-inch valve capable of balance to 0.5 GPM. Grooved or flanged ends for 2-1/2-inches through 12-inches.
 2. Throttling Range: 4 turns of valve stem minimum.

3. Differential pressure read-out ports with integral check valves across valve seat area.
 4. Memory stop.
 5. Calibrated nameplate.
 6. Drain port.
- C. Calibrated Iron Globe Valve
1. Y-pattern globe style design. Precision flow measurement, precision flow balancing, memory stops, positive shut-off to a minimum of 250 psi, drain port suitable for hose bibb fitting. Threaded or solder ends for 1/2-inch through 2-inches. 1/2-inch valve capable of balance to 0.5 GPM. Grooved or flanged ends for 2-1/2-inches through 12-inches.
 2. Throttling Range: 4 turns of valve stem minimum.
 3. Differential pressure read-out ports with integral check valves across valve seat area.
 4. Memory stop.
 5. Calibrated nameplate.
 6. Drain port.
- D. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.
- E. Size 2 inch and Smaller:
1. Provide calibrated globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
 2. Metal construction materials consist of bronze or brass.
 3. Non-metal construction materials consist of Teflon or EPDM.
 4. Maximum Service Operation: 300 psi at 250 degrees F.
- F. Size 2-1/2 inch and Larger:
1. Provide calibrated globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, or NORLYL.
 4. Maximum Service Operation: 175 psi at 250 degrees F.

2.06 RELIEF VALVES

- A. Manufacturers:
1. Armstrong International, Inc.
 2. ITT Bell & Gossett.
 3. Consolidated.
 4. Kunkle.
 5. Cash Acme.
- B. Bronze or steel body, stainless steel stem and springs, pressure rated to 160 psi at 250 degrees F, conforming to Section IV of ASME Code, size per manufacturer's recommendations based on Code, setting as indicated on drawings.

2.07 PRESSURE REDUCING VALVES

- A. Manufacturers:
1. Armstrong International, Inc.
 2. ITT Bell & Gossett.
 3. Taco, Inc.
 4. Amtrol.
 5. Cash Acme.
- B. Materials of Construction:

1. Valve Body: Constructed of iron for steel piping installation, brass for copper piping installation.
 2. Internal Components: Construct of brass.
- C. Provide integral low inlet pressure check valve and removable strainer.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at system high points where automatic air vents are not used, and as indicated.
- C. Provide automatic air vents at high points where air can collect in water systems and where indicated. Route drain lines from vent to nearest floor drain. Install 3/4-inch globe shut-off valve ahead of air vent. Install ball valve where bucket drainage is required.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide valved drain and hose connection on strainer blow down connection. Pipe blow off full size and terminate over floor drains except finned tube, reheat coils, fan coils, terminal units, and unit heaters.
 1. Applied Strainer locations:
 - a. Cast iron wye, chilled, heating, and heat recovery water, low pressure steam, low pressure condensate.
 - b. Bronze wye, in piping 2-inch and smaller, medium, and high pressure steam and condensate.
 - c. Cast iron, high pressure wye, in piping 2-1/2-inch and larger, medium, and high pressure steam and condensate.
 - d. Basket, in piping 2-1/2-inch and larger, condenser water inlet to pumps.
- F. Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Support suction diffuser and piping from same surface as pump base is supported unless shown otherwise. Adjust foot so that pump inlet does not carry piping weight. Pipe pressure gauges to gauge port, and blow down to drain with ball shut-off valve. Remove temporary strainers after cleaning systems.
- G. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
- H. Support pump fittings with floor-mounted pipe and flange supports.
- I. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks and as indicated.
- J. Integral coil connectors are prohibited except where specifically indicated on the drawings.
- K. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- L. Pipe relief valve outlet to nearest floor drain.
- M. Clean and flush glycol system before adding glycol solution, see Section 23 2500.
- N. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
- O. Perform tests determining strength of glycol and water solution and submit written test results.

END OF SECTION 23 2114

**SECTION 23 2123
HYDRONIC PUMPS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line circulators.
- B. Condensate pumps.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete.
- B. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- C. Section 23 0716 - HVAC Equipment Insulation.
- D. Section 23 0719 - HVAC Piping Insulation.
- E. Section 23 2113 - Hydronic Piping.
- F. Section 23 2114 - Hydronic Specialties.
- G. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. UL 778 - Standard for Motor-Operated Water Pumps.

1.04 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data:
 - 1. Performance Curves
 - 2. Efficiency Curves
 - 3. NPSH Curve
 - 4. Motor Data
 - 5. Operating Weight
 - 6. Pressure Ratings
 - 7. Capacity, head, and power requirements as shown on Drawings.
- C. Shop Drawings.
- D. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- E. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- F. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.
- B. Select pump impellers such that impellers are not greater than minimum impeller size plus 90 percent of the difference between the maximum and minimum impeller size for pump selected.
- C. Select motor to be non-overloading under all operating conditions.
- D. Select pump with a minimum efficiency as listed in schedule.
- E. Provide couplings and seals suitable for application (including temperature, pH, glycol solution concentration, and loads over full range of pump operation).
- F. Provide factory aligned pumps and motors.
- G. Provide field realignment after installation by manufacturer's representative for pumps with flexible couplings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bell and Gossett
- B. Paco
- C. Peerless
- D. Goulds
- E. Armstrong
- F. Taco
- G. Aurora

2.02 HVAC PUMPS - GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Minimum Quality Standard: UL 778.
- C. Base Mounted Pumps: Aligned by qualified millwright.
- D. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.

2.03 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 175 psi maximum working pressure.
- B. Casing: Cast iron, with flanged pump connections.
- C. Impeller: Bronze keyed to shaft.
- D. Bearings: Oil-lubricated bronze sleeve.
- E. Shaft: Alloy steel with bronze sleeve, integral thrust collar.
- F. Seal: Mechanical seal , 275 degrees F maximum continuous operating temperature.
- G. Drive: Rigid coupling.

2.04 CONDENSATE PUMPS

- A. Type: Pump for removal of evaporator condensate and humidifier overflow, complete with integral float switch, receiver, power cord, safety switch, and check valve.
- B. Factory piped, wired, assembled, and tested.
- C. Components:
 - 1. Integral Float Switch
 - 2. Receiver
 - 3. Power Cord
 - 4. Safety Switch
 - 5. Discharge Check Valve

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

- C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D. Provide line sized shut-off valve and strainer on pump suction, and line sized check valve and balancing valve on pump discharge as shown on drawings.
- E. Provide air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals, piped to and discharging into floor drains.
- G. Check, align, and certify alignment of base-mounted pumps prior to start-up.
- H. Install close-coupled and base-mounted pumps on concrete housekeeping base, inertia base, with anchor bolts, set and level, and grout in place. Refer to Section 03 3000.
- I. Lubricate pumps before start-up.

END OF SECTION 23 2123

**SECTION 23 2500
HVAC WATER TREATMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Materials.
 - 1. System cleaner.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2114 - Hydronic Specialties.
- C. Section 26 0583 - Wiring Connections.

1.03 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- E. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- F. Certificate: Submit certificate of compliance from Authority Having Jurisdiction indicating approval of chemicals and their proposed disposal.
- G. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.
- H. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Sufficient chemicals for treatment and testing during required maintenance period.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience and approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. US Water Services
- B. Nalco
- C. Mogul
- D. Chemax
- E. Chemcoa
- F. DuBois Chemicals
- G. Industrial Treatment of Water
- H. Other Manufacturer/Suppliers: Submit substitution request.

2.02 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
- B. Comply with UL (DIR) requirements.
- C. Perform work in accordance with local health department regulations.
- D. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation.

2.03 MATERIALS

- A. System Cleaner:
 - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.
 - 2. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite or microbiocides such as quarternary ammonia compounds, tributyltin oxide, methylene bis (thiocyanate).

PART 3 EXECUTION

3.01 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

- A. Concentration:
 - 1. One pound per 100 gallons of water for hot systems and one pound per 50 gallons of water for cold systems.
- B. Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
- C. Chilled Water Systems:
 - 1. Circulate for 48 hours, then drain systems as quickly as possible.
 - 2. Refill with clean water, circulate for 24 hours, then drain.
 - 3. Refill with clean water and repeat until system cleaner is removed.
- D. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect.
- E. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.
- F. Remove, clean, and replace strainer screens.
- G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.04 FINAL ADJUSTMENT

- A. When the systems are accepted by the Owner the chemical treatment supplier to make final adjustments in the required concentrations.

- B. Submit report of indicating initials and final concentrations and system chemistry.
- C. Furnish sufficient chemicals to constitute one year's supply for systems.

3.05 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
 - 1. Provide minimum of two hours of instruction for two people.
 - 2. Have operation and maintenance data prepared and available for review during training.
 - 3. Conduct training using actual equipment after treated system has been put into full operation.

END OF SECTION 23 2500

**SECTION 23 3100
HVAC DUCTS AND CASINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ductwork.
- B. Flexible ductwork.
- C. Casings and plenums.
- D. Kitchen hood and grease exhaust ductwork.
- E. Duct cleaning.

1.02 RELATED REQUIREMENTS

- A. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- B. Section 23 0713 - Duct Insulation.
- C. Section 23 3300 - Air Duct Accessories.
- D. Section 23 3700 - Air Outlets and Inlets.

1.03 REFERENCE STANDARDS

- A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- D. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.
- E. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- F. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- H. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- J. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines.
- K. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
- L. UL 1978 - Grease Ducts.
- M. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies.

1.04 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work.
- D. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed specified requirements.
- E. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).

- F. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.06 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to comply with NFPA 90A standards.
- B. Ducts: Galvanized steel, unless otherwise indicated.
- C. Low Pressure Supply: 2 inch w.g. pressure class, galvanized steel.
- D. Medium Pressure Supply: 4 inch w.g. pressure class, galvanized steel.
- E. Return and Relief: 2 inch wg pressure class, galvanized steel.
- F. General Exhaust: 2 inch wg pressure class, galvanized steel.
- G. General Exhaust - Moisture Laden Air: 2 inch w.g. pressure class, aluminum.
- H. Kitchen Cooking Hood Heat/Vapor Exhaust: 2 inch w.g. pressure class, stainless steel.
 - 1. Construct of 18 gauge, 0.0500 inch stainless steel using continuous external welded joints in rectangular sections.
- I. Dishwasher Exhaust: 2 inch w.g. pressure class, stainless steel.
 - 1. Construct of 18 gauge, 0.0500 inch stainless steel using continuous external welded joints in rectangular sections.
- J. Kitchen Cooking Grease Exhaust: 2 inch w.g. pressure class, un-galvanized steel.
 - 1. Construct of 16 gauge un-galvanized steel.
 - 2. Construction:
 - a. Liquidtight with continuous external weld for all seams and joints.
 - 3. Access Doors:
 - a. Same material as ductwork.
 - b. Latches easily operable by hand.
 - c. Liquid tight.
- K. Outside Air Intake: 1 inch wg pressure class, galvanized steel.
- L. Combustion Air: 1 inch wg pressure class, galvanized steel.
- M. Emergency Generation Ventilation: 1 inch wg pressure class, galvanized steel.
- N. Transfer Air and Sound Boots: 1/2 inch w.g. pressure class, galvanized steel.

2.02 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Un-Galvanized Steel for Ducts: ASTM A1008/A1008M Designation CS (commercial steel), cold-rolled.
- C. Aluminum for Ducts: ASTM B209/B209M; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
- D. Stainless Steel for Ducts: ASTM A666, Type 304.
- E. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
2. VOC Content: Not more than 250 g/L, excluding water.
3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
4. For Use with Flexible Ducts: UL labeled.

2.03 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- D. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- F. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- G. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.04 MANUFACTURED DUCTWORK AND FITTINGS

- A. Flat Oval Ducts: Machine made from round spiral lockseam duct.
 1. Manufacture in accordance with SMACNA (DCS).
 2. Fittings: Manufacture at least two gauges heavier metal than duct.
 3. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. Double Wall Insulated Flat Oval Ducts: Machine made from round spiral lockseam duct.
 1. Manufacture in accordance with SMACNA (DCS).
 2. Fittings: Manufacture with solid inner wall.
 3. Inner Wall: Perforated galvanized steel.
 4. Insulation:
 - a. Thickness: 2 inch fiberglass.
 - b. Insulation K Value: 0.27 BTU/HR/SF degrees at 75 degrees F.
 - c. Insulation Density: 1 pcf.
- C. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
 1. Manufacture in accordance with SMACNA (DCS).
 2. Insulation:
 - a. Material: Fiberglass.
- D. Double Wall Insulated Rectangular Ducts: Rectangular spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
 1. Manufacture in accordance with SMACNA (DCS).
 2. Insulation:
 - a. Material: Fiberglass.
- E. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
 1. Manufacture in accordance with SMACNA (DCS).
- F. Round Ducts: Round lockseam duct with galvanized steel outer wall.

1. Manufacture in accordance with SMACNA (DCS).
- G. Kitchen Hood and Grease Exhaust Ducts:
 1. Fabricate in accordance with ductwork manufacturer's instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.
- H. Kitchen Cooking Hood and Grease Exhaust - Factory Fabricated:
 1. Nominal 3 inches thick ceramic fiber insulation between 20 gage, 0.0375 inch, Type 304 stainless steel liner and 24 gage, 0.0239 inch aluminized steel sheet outer jacket.
 2. Tested and UL listed for use with commercial cooking equipment in accordance with NFPA 96.
 3. Certified for zero clearance to combustible material in accordance with:
 - a. UL 2221 with a 2 hour rating.
 4. Materials and construction of the modular sections and accessories to be in accordance with the terms of the following listings:
 - a. UL 1978.
 - b. UL 2221.
 5. Manufacturers:
 - a. AMPCO by Hart & Cooley, Inc.; Z-Clear.
 - b. DuraVent; DuraZDuct (DIS3Z).
 - c. Selkirk Corporation; ZeroClear (IPS-Z3).
 - d. Metal-Fab G Series.

2.05 CASINGS AND PLENUMS

- A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gauge, 0.0478 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
- D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gauge, 0.0598 inch sheet steel back facing and 22 gauge, 0.0299 inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb/cu ft minimum glass fiber insulation media, on inverted channels of 16 gauge, 0.0598 inch sheet steel.

PART 3 EXECUTION

3.01 APPLIED LOCATIONS

- A. Supply ductwork on downstream side of terminal box. Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 0713 - Duct Insulation.
- B. Supply Ductwork from Spin-In Fittings to Supply Outlet Collar Connection: Flexible duct, maximum 4-foot length.
- C. Return Air Trunk Ductwork from End Run to Unit Connection: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 0713 - Duct Insulation.
- D. Exhaust Ductwork: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 0713 - Duct Insulation.
- E. Ductwork between Transfer Grilles: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 0713 - Duct Insulation.
- F. Exposed or Visible Ductwork in Finished Spaces: Sheet metal as specified for application, lined where indicated on the Drawings or as specified in Section 23 0713 - Duct Insulation.

- G. Acoustical lined plenums on inlet and outlet of rooftop units. Plenum size sufficient for duct connections as shown on plans, minimum plenum size, and same as unit opening.
- H. Stainless Steel Ducts:
 - 1. Type 304:
 - a. For 10-feet downstream of duct mounted humidifiers.
 - b. Kitchen steam exhaust system, dishwasher exhaust, sterilizer exhaust, cart wash exhaust.
- I. Aluminum ducts:
 - 1. Natatorium/Pool exhaust systems.
 - 2. Dedicated shower exhaust systems.
 - 3. Shower and moisture laden air exhaust branch ducts up to the point of connection to the main exhaust system.

3.02 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Flexible Ducts:
 - 1. Make connections at ends using draw band strap and a minimum of 2 wraps of duct tape.
 - 2. Suspend center spans from structure above using wire as required by code. Connect to manufacturer's eyelet on jacket or use 1-inch wide galvanized steel strap with single loop at top and smooth edges.
 - 3. Suspending duct by laying it on the ceiling is prohibited.
 - 4. Avoid crimping flex duct. Changes in direction made using 2D radius. Duct connections to grilles, registers, and diffusers using less than 2D radius bends are not acceptable. Where space is constricted, use sheet metal elbows or Thermaflex Flex Boots (or equal).
- E. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.
- F. Aluminum Duct:
 - 1. Slope minimum of 1/4-inch per foot of run toward the grille.
 - 2. Install similar to galvanized duct work per SMACNA standards.
 - 3. Provide dielectric protection when joining aluminum duct to steel duct by utilizing neoprene flexible connections or other approved method.
 - 4. Use aluminum straps and hangers to support aluminum ductwork.
- G. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- H. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- I. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- J. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- K. Use double nuts and lock washers on threaded rod supports.
- L. Connect terminal units to rigid supply ducts with minimum of 3 ducts diameters of straight duct.
- M. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
- N. At exterior wall louvers, seal duct to louver frame and install blank-out panels.
- O. Ductwork, Exposed or Visible in Finished Areas:

1. Use extreme care in handling and installing.
 2. Replace dented or damaged sections.
 3. Install ductwork straight and true, parallel to building lines.
 4. Make connections with pop rivets using couplings where applicable. Grind raw edges smooth and apply paintable sealant to cover imperfections.
 5. Remove excess sealant to provide a finished joint.
 6. Provide floor, wall, and ceiling plates as specified in Section 23 0500 - Common Work Results for HVAC.
 7. Finish, clean and prime ductwork, and hangers for painting.
- P. Single Wall Housing Plenums:
1. Install housing plenums in accordance with SMACNA (DCS), latest edition.
 2. Joints and seams sealed with high pressure duct sealer or gaskets and fastened with bolts, screws, or pop rivets.
 3. Pipe, duct, conduit, and control penetrations sealed to prevent air leakage using close off sheets and strips.
 4. Securely anchor housing panels to floor or roof curbs.
 5. Block outside air or return air dampers open to prevent damage during construction until automatic control system is operational and adjusted.
 6. Provide access doors where indicated on drawings and where required to provide access for cleaning and maintenance. Access doors installed to open against air pressure.
 7. Slope plenum and connected ductwork to drain towards the exterior louver or building exterior opening.
 8. For single wall plenums installed behind exterior louvers or wall openings, slope plenum floor and connected ductwork at 1/4-inch/foot to drain towards the exterior louver or opening.
 9. For single wall plenums installed below roof ventilators or roof openings, slope floor of plenum at 1/4-inch/foot to drain connection. Pipe drain connection to floor drain.

3.03 CLEANING

- A. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

END OF SECTION 23 3100

**SECTION 23 3300
AIR DUCT ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Industrial blast-suppression dampers.
- D. Combination fire and smoke dampers.
- E. Duct access doors.
- F. Duct test holes.
- G. Flexible duct connections.
- H. Volume control dampers.
- I. Miscellaneous products:
 - 1. Internal strut end plugs.
 - 2. Duct opening closure film.
- J. Duct sealer.
- K. Bird screen.

1.02 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- C. NFPA 92 - Standard for Smoke Control Systems.
- D. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- F. UL 555 - Standard for Fire Dampers.
- G. UL 555S - Standard for Smoke Dampers.
- H. UL 1978 - Grease Ducts.

1.03 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC, for submittal procedures.
- B. Product Data.
- C. Shop Drawings.
- D. Manufacturer's Installation Instructions.
- E. Project Record Drawings.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

- A. Manufacturers:
 - 1. Krueger-HVAC, Division of Air System Components.
 - 2. Ruskin Company, a brand of Johnson Controls.
 - 3. Titus HVAC, a brand of Johnson Controls.

- B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.

2.02 BACKDRAFT DAMPERS - METAL

- A. Manufacturers:
 - 1. Nailor Industries, Inc.
 - 2. Ruskin Company, a brand of Johnson Controls.
- B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 INDUSTRIAL BLAST-SUPPRESSION DAMPERS

- A. Certification: AMCA 500-D certified for use as bubble-tight (i.e. zero leak or zero flow) for duct pressures up to 10 in wg when fully-closed and able to withstand airflow velocities up to 3,500 ft/min when fully open. Show certification stamp on product sheet and damper-applied tag.
- B. Temperature Service Range: Minus 40 to 250 degrees F (minus 40 to 121 degrees C).

2.04 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
 - 1. Pottorff.
 - 2. Ruskin Company, a brand of Johnson Controls.
 - 3. Greenheck.
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C. Partitions up to 2-hour rating: 1-1/2 hour rated dampers.
- D. Partitions over 2-hour rating: 3 hour rated dampers.
- E. Provide factory sleeve and collar for each damper.
- F. Multiple Blade Dampers: Fabricate with 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
 - 1. Low Pressure Duct Systems: Triple V-groove shape.
 - 2. Medium and High Pressure Duct Systems: Airfoil shape.
- G. Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position.
- H. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.
- I. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.
- J. Provide round or oval duct connections where required.

2.05 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc, a DMI Company:
 - 2. Ruskin Company, a brand of Johnson Controls.
 - 3. SEMCO LLC.
- B. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 2 inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.
 - 2. Up to 18 inches Square: Provide two hinges and two sash locks.

3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.
 4. Larger Sizes: Provide an additional hinge.
 5. High Temperature Duct Access Doors:
 - a. Comply with NFPA 96.
 - b. Comply with UL 1978.
- C. Access doors with sheet metal screw fasteners are not acceptable.

2.06 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.07 MISCELLANEOUS PRODUCTS

- A. Internal Strut End Plugs: Combination end-mounting and sealing plugs for metal conduit used as internal reinforcement struts for metal ducts; plug crimped inside conduit with outside gasketed washer seal.
 1. Manufacturers:
 - a. Carlisle HVAC Products; Dynair Internal Duct Reinforcement - Conduplugs.
- B. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
 1. Thickness: 2 mils.
 2. High tack water based adhesive.
 3. UV stable light blue color.
 4. Elongation Before Break: 325 percent, minimum.
 5. Manufacturers:
 - a. Carlisle HVAC Products; Dynair Duct Protection Film.

2.08 DUCT SEALER:

- A. Suitable for indoor/outdoor use, including application in moist conditions, rated to 10-inch wg.
- B. Maximum Flame Spread/Smoke Developed Rating of 25/50, maximum VOC of 420 g/L less water.
- C. SCAQMD Rule 1168 compliant.

2.09 BIRD SCREEN:

- A. Corrosion-resistant screen installed in air intake openings that terminate outdoors. Opening sizes as described below, or as defined by the local AHJ, whichever is smaller.
 1. Residential occupancies: Not less than 1/4-inch and not larger than 1/2-inch.
 2. Non-residential occupancies: Not less than 1/4-inch and not larger than 1/2-inch.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 3100 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside where automatic dampers are not indicated, and where indicated.

- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, humidifiers, air flow stations, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 and every 10-feet and at each change in direction of kitchen exhaust duct. Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire and/or smoke rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Install smoke dampers and combination fire and smoke dampers in accordance with NFPA 92.
- G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- H. For fans developing static pressures of 5.0 inches and over, cover flexible connections with leaded vinyl sheet, held in place with metal straps.
- I. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- J. Provide balancing dampers on high velocity systems where indicated.
- K. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- L. Provide concealed damper regulators where balancing dampers are installed in inaccessible locations. Mount flush with ceiling, coordinate finish of cover plate with Architect.
- M. Drip Pans:
 - 1. Install under each cooling coil and exhaust heat recovery coil as indicated.
 - 2. Provide drain connection from each drip pan and pipe to nearest floor drain through trap.
 - 3. Drip pans over 6-feet in length require drain connections from both ends.
 - 4. Pitch drip pans in direction of air flow and to drain.
- N. Louver Blank-off Panels: Install blank-off panels on unused portions of louvers.
- O. Water Eliminators: Install water eliminators as indicated on drawings.

END OF SECTION 23 3300

**SECTION 23 3700
AIR OUTLETS AND INLETS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Diffusers and grilles.

1.02 REFERENCE STANDARDS

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating.
- B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets.
- C. SMACNA (ASMM) - Architectural Sheet Metal Manual.

1.03 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Project Record Documents: Record actual locations of air outlets and inlets.

1.04 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.
- C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Carnes.
- B. Krueger-HVAC.
- C. Greenheck.
- D. Price Industries.
- E. Titus.

2.02 DIFFUSERS AND GRILLES

- A. Ceiling Supply Diffuser (C-1):
 - 1. Perforated face modular diffuser with adjustable modular core, steel panel, square or rectangular neck size as indicated, discharge pattern as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan).
 - 2. White baked enamel finish, Titus PMC.
- B. Ceiling Return/Exhaust Grille (C-2):
 - 1. Perforated face modular ceiling grille, steel panel, with duct adapters for round or rectangular as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan).
 - 2. White baked enamel finish, Titus PAR.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.

- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black.
- G. Set pattern control for directions of throw as shown on Drawings prior to air balancer arriving on Project.

END OF SECTION 23 3700

**SECTION 23 4000
HVAC AIR CLEANING DEVICES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Disposable, extended area panel filters.
- B. Extended surface high efficiency media filters.
- C. Filter frames and housings.
- D. Filter gauges.

1.02 REFERENCE STANDARDS

- A. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- B. MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components, and Related Products: Performance-Test Methods.
- C. UL 900 - Standard for Air Filter Units.
- D. UL 1995 - Heating and Cooling Equipment.
- E. UL 2998 - Environmental Claim Validation Procedure (ECVP) for Zero Ozone Emissions from Air Cleaners.

1.03 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate assembly and change-out procedures.
- E. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.

1.04 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 FILTER MANUFACTURERS

- A. AAF International/American Air Filter.
- B. The Camfil Group.
- C. Cambridge.
- D. Eco-Air Products.
- E. Flanders Precisionaire.

2.02 PERFORMANCE REQUIREMENTS

- A. Comply with the rating requirements in AHRI 851 (SI).

2.03 DISPOSABLE, EXTENDED AREA PANEL FILTERS

- A. Media: UL 900 Class 1, pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid by corrugated aluminum separators.
 - 1. Frame: Non-flammable.
 - 2. Nominal size: 24 by 24 inches.
 - 3. Nominal thickness: 2 inches.

- B. Minimum Efficiency Reporting Value (MERV): 8, when tested in accordance with ASHRAE Std 52.2.
- C. Rating, per ASHRAE Std 52.2:
 - 1. Weight arrestance: 85 percent.
 - 2. Initial resistance at 500 FPM face velocity: 0.30 inch WG.
 - 3. Recommended final resistance: 0.9 inch WG.

2.04 EXTENDED SURFACE HIGH EFFICIENCY MEDIA FILTERS

- A. Media: Pleated, water-resistant glass fiber with aluminum separators; in 16 gauge, 0.0598 inch steel holding frame with corrosion resistant coating.
 - 1. Nominal Size: 24 by 24 by 6 inches deep.
- B. Minimum Efficiency Reporting Value (MERV): 13A, when tested in accordance with ASHRAE Std 52.2.
- C. Performance Rating, per ASHRAE Std 52.2:
 - 1. MIL-STD-282 Test 0.3 Micron Dioctyl Phthalate Smoke (DOP) Efficiency: 99 percent.
 - 2. Initial Resistance at 150 fpm Face Velocity: 0.35 inch WG.
 - 3. Recommended Final Resistance: 1.5 inch WG.

2.05 FILTER FRAMES AND HOUSINGS

- A. General: Fabricate filter frames and supporting structures of 16 gage, 0.0598 inch extruded aluminum T-section construction with necessary gasketing between frames and walls.
- B. Standard Sizes: Provide for interchangeability of filter media of other manufacturers; for panel filters, size for 24 by 24 inches filter media, minimum 2 inches thick; for extended surface and high efficiency particulate air filters, provide for upstream mounting of panel filters.
- C. Side Servicing Housings: Flanged for insertion into ductwork, of reinforced 16 gage, 0.0598 inch galvanized steel; access doors with continuous gasketing and positive locking devices on both sides; extruded aluminum tracks or channels for filters with positive sealing gaskets.

2.06 FILTER GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc
 - 2. H.O. Trerice Co
 - 3. Weiss Instruments
 - 4. Magnehelic.
- B. Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case, vent valves, black figures on white background, front recalibration adjustment, range 0-2.0 inch WG, 2 percent of full scale accuracy.
- C. Inclined Manometer: One piece molded plastic with epoxy coated aluminum scale, inclined-vertical indicating tube and built-in spirit level, range 0-3 inch WG, 3 percent of full scale accuracy.
- D. Accessories: Static pressure tips with integral compression fittings, 1/4 inch aluminum tubing, 2-way or 3-way vent valves.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Install filter gauge static pressure tips upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position. Adjust and level.
- D. Do not operate fan system until filters are in place. Replace temporary filters used during construction and testing, with clean set.

END OF SECTION 23 4000

SECTION 23 7223
PACKAGED AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Casing.
- B. Fans.
- C. Plate heat exchanger section.
- D. Filters.
- E. Dampers.
- F. Drain pan.
- G. Electrical.
- H. Controls.
- I. Accessories.
- J. Service accessories.

1.02 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- F. NFPA 70 - National Electrical Code.
- G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- H. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Manufacturer's installation instruction, product data, and engineering calculations.
- C. Shop Drawings: Show design and assembly of energy recovery unit and installation and connection details.
- D. Samples: Submit sample showing custom paint colors.
- E. Manufacturer's Qualification Statement.
- F. Closeout Submittals: Submit manufacturer's operation and maintenance instructions.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Spare Parts: One of each kind of filter.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Firm regularly engaged in manufacturing energy recovery units.
 - 2. Products in satisfactory use in similar service for not less than five years.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store in manufacturer's unopened packaging.
- B. Store products to be installed indoors in dry, heated area.

1.06 WARRANTY

- A. See Section 23 0500 - Common Work Results for HVAC, for additional warranty requirements.
- B. Warranty ventilator to be free from defects in material and workmanship and of all parts for period of 3 years from date of Substantial Completion.
- C. Warranty energy recovery device to be free from defects in material and workmanship for 3 years under circumstances of normal use.
- D. Warranty motor to be free from defects in material and workmanship for 7 years under circumstances of normal use.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Renewaire.
- B. OXYGEN8.
- C. Innovent.
- D. Semco.

2.02 CASING

- A. Wall, Floor, and Roof Panels:
 - 1. Panels: Removable.
 - 2. Construction: 1 inch thick, double wall box construction, with formed edges of exterior wall overlapping formed edges of interior wall.
 - 3. Exterior Wall: Galvanized steel sheet.
 - a. 18 gauge.
 - b. Color: Factory finish.
 - 4. Interior Wall: Aluminized steel.
 - a. 20 gage, 0.0359 inch .
 - 5. Insulation:
 - a. 1 inch insulated fiberglass.
 - b. Panel Cores: Mineral wool board.
 - c. Mold Resistance: "Pass" when tested according to ASTM C1338.
 - d. Fungal Resistance: No growth when tested according to ASTM G21.
 - e. Bacteria Resistance: No growth when tested according to UL 181.
 - f. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84 or UL 723.
 - g. Smoke Developed Index (SDI): 50, maximum, when tested in accordance with ASTM E84 or UL 723.
 - h. Secure insulation to unit with waterproof adhesive and permanent mechanical fasteners.
 - 6. Roof Panel: Weatherproof.
 - 7. Fasteners: Stainless steel.
 - 8. Isolation and Seal: Form continuous, thermally isolated, weather tight seal between inner wall of panels and structural framing with closed cell PVC foam gasketing.
 - 9. Seams: Sealed, requiring no caulking at job site.
 - 10. Coating:
 - a. Polyurethane enamel.
- B. Access Panels: Provide access to components through a large, tightly sealed and easily removable panel.
- C. Doors:
 - 1. Construct doors of same construction and thickness as wall panels.
 - 2. Hardware:

- a. Hinges: Aluminum.
 - b. Corrosion-resistant.
 - c. Provide exterior handle and interior 3-point latching device.
 - d. Prop Rod: Capable of propping doors in open position.
 - e. Wind Restraint: Door chain with spring to absorb force of door swinging open.
 - f. Gasket: P-shaped extruded neoprene.
 - g. Label each door to identify equipment located within.
- D. Trim: 0.08 inches aluminum, continuously welded.
 - E. Install panels on structural framing with self-tapping stainless steel screws with integral neoprene-backed stainless steel washers.
 - F. Duct Connection Collars: 0.08 inches aluminum, continuously welded.
 - G. Weather Hood: Provide on fresh air inlet and exhaust air outlet; removable for access.
 - 1. Construction: ASTM A653/A653M, G90/Z275 galvanized, 20 gauge, 0.0359 inch steel sheet.
 - 2. Screening: Expanded aluminum bird screen.
 - 3. Fresh Air Weather Hood: Maintain a face velocity less than 340 feet/min.

2.03 FANS

- A. Provide separate fans for exhaust and supply blowers.
- B. Fan and motor assemblies to be mounted on a common base with vibration isolation provided from the casing and unit frame.
- C. Fans:
 - 1. Individually driven with a dedicated motor.
 - 2. Centrifugal.
 - 3. AMCA-rated.
 - 4. Provide with non-overloading characteristics.
- D. Bearings:
 - 1. Bearings: Permanently lubricated sealed ball bearings.
 - 2. Rated for not less than 200,000 hours of operation with accessible greased fittings.
- E. Motors:
 - 1. Motors: ODP type.
 - 2. Efficiency: High.
 - 3. Motor Slide Bases: Removable and adjustable.
 - 4. Fan Motor: Thermal overload protected.
 - 5. Fan Motor: UL listed and labeled.
- F. Drives:
 - 1. Fans: Belt driven.
 - 2. Fixed sheaves for motors over 5 horsepower.
 - 3. Variable pitch drives for motors 5 horsepower and under.
 - 4. Multiple belt drives for motors over 2 horsepower.
 - 5. Sheaves statically and dynamically balanced.
 - 6. Service Factor: 1.2.
- G. Belt Guards: Full sized, hinged, painted with high-visibility safety color, and accessible with standard tools.

2.04 PLATE HEAT EXCHANGER SECTION

- A. Flat plate air-to-air type with no moving parts or secondary heat transfer surfaces.
- B. Heat exchanger to withstand differential pressures to 10 inches wc and operate at temperatures at 220 degrees F.
- C. Seal corners with silicone and plate edges both mechanically and with sealant to prevent cross contamination.

- D. Constructed of 0.008-inch thick 99.5 percent pure aluminum.
- E. House in an aluminum tube frame.
- F. Entire transfer surface visible for inspection and cleaning without removing the exchanger.
- G. Face/Bypass Dampers:
 - 1. Dampers opposed blade type.
 - 2. Multi-blade type, except where either dimension is less than 10 inches a single blade may be used.
 - 3. Maximum blade length to be 48 inches.
 - 4. Provide parallel blades for positive or modulating.
 - 5. Blades to be interlocking, minimum 16 gauge galvanized steel.
 - a. Dampers have compression type edge seals and side seating stops.
 - b. Reinforce damper blades, have continuous full length axle shafts, axle to axle linkage, and/or operating jackshafts as required to provide coordinated tracking of blades.
 - c. Maximum air leakage of 3 cfm per square foot at 4 inches wg pressure. Tested in accordance with AMCA Standard 500.

2.05 FILTERS

- A. Provide filters in the supply and exhaust steams upstream of the heat exchanger.
- B. Provide medium efficiency and high efficiency pleated filters (as scheduled).
- C. Refer to Section 23 4000 - HVAC Air Cleaning Devices.
- D. Filter Racks: Bolt-on rack constructed of 0.08 inches, minimum, thick aluminum with hinged side access door and snap fasteners.
- E. Pre-Filter: pleated filters, 2 inches thick on outside air inlet.
- F. Filter Removal Hooks: Provide means to remove filters that are not immediately accessible from exterior of unit
- G. Provide spare set of filters.

2.06 DAMPERS

- A. Motorized Dampers:
 - 1. Locations:
 - a. Outside air intake.
 - b. Exhaust air outlet.
 - 2. Type: Motorized two position parallel blade damper with blade seals.
 - 3. Motorized Damper: Roll-formed structural hat channels, reinforced at the corners,
 - 4. Type: Class I motorized damper.
 - 5. Performance: Maximum leakage rate of 4 cfm per square foot at 1.0 inches water gauge per AMCA 500-D.

2.07 DRAIN PAN

- A. Construction:
 - 1. Stainless steel with copper drain connection.
 - 2. Double sloped at least 0.125 in./ft from the horizontal toward the drain outlet or otherwise designed such that water drains freely from the pan whether the fan is on or off.
- B. Dimensions:
 - 1. Extend under water producing device for proper drainage of water droplets and condensate and extend downstream from the leaving face of the water producing device a distance of either:
 - a. One half the installed vertical dimension of the coil, or
 - b. As necessary to limit water droplet carryover beyond the drain pan to 0.0044 oz per square foot of face area per hour under peak dew-point design conditions.

2.08 ELECTRICAL

- A. Motor Control Panels: UL listed.
- B. Include necessary motor starters, fuses, transformers and overload protection according to NFPA 70.
- C. Provide single-point field connection to power supply.
- D. Provide non fused main disconnect integral to control panel.
- E. Install wiring in accordance with NFPA 70.
- F. Wiring: Enclosed in flexible, liquid tight steel conduit.

2.09 CONTROLS

- A. DDC Controls Interface
 - 1. Located within unit mounted control panel.
 - 2. Reference Section 23 0993 - Sequence of Operations for HVAC Controls.

2.10 ACCESSORIES

- A. Airflow Monitor:
 - 1. Include integral airflow monitoring station with ability to read both ventilation and exhaust airflow expressed in cfm.
 - 2. Mount monitor gauge on unit exterior and make casing connection watertight.
- B. Freeze Protection Thermostat:
 - 1. Equip unit with thermostat such that unit can be stopped when temperature drops to 23 degrees F.

2.11 SERVICE ACCESSORIES

- A. Internal Service Lights: Provide vapor tight light with protective cage and minimum 40 watt bulb.
- B. Electrical Receptacle:
 - 1. Provide duplex, ground fault interrupter type receptacle.
 - 2. Provide re-settable circuit breaker in control panel.
- C. Switch:
 - 1. Two Position Type: Service and operate.
- D. Electrical Components: Factory wired for single point power connection.
 - 1. 60 Hz power connection.
 - 2. Isolate electrical box from the airflow.
 - 3. Protect all integral wires and connections.
 - 4. Electrical Components: UL Listed.
 - 5. Electrical Panel: NEMA 3R mounted on the unit exterior for ease of access.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that structure is ready for installation of unit, that openings in deck for ductwork, if required, are correctly sized and located, and that mechanical and electrical utilities supplying unit are of correct capacities and are accessible.

3.02 INSTALLATION

- A. Coordinate roof penetration with others.
- B. Provide roof curb per Section 23 0529.
- C. Install unit where shown with air filters in place before operating unit. Comply with manufacturer's recommendation.
- D. Provide minimum of 3-inch trap seal on condensate drain connections.
- E. Provide flexible connections between fans and the connected ducts or plenums.
- F. Provide accurate alignment between fan and duct.

3.03 SYSTEM STARTUP

- A. Provide services of manufacturer's authorized representative to provide start up of unit.
- B. Comply with manufacturer's instructions.

3.04 CLEANING

- A. Clean air plenums, interior and exposed-to-view surfaces prior to Substantial Completion.

3.05 TESTING AND ADJUSTING/PERFORMANCE TEST

- A. Test to show compliance with scheduled performance.
- B. Tests performed by the manufacturer's representative.

END OF SECTION 23 7223

SECTION 23 8126.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air cooled condensing units.
- B. Indoor air handling (fan and coil) units for ducted systems.
- C. Indoor air handling (fan and coil) units for ductless systems.
- D. Controls.

1.02 RELATED REQUIREMENTS

- A. Section 23 0913 - Instrumentation and Control Devices for HVAC.
- B. Section 23 3100 - HVAC Ducts and Casings.
- C. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems.
- D. ASHRAE Std 23.1 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Pressures of the Refrigerant.
- E. NEMA MG 1 - Motors and Generators.
- F. NFPA 54 - National Fuel Gas Code.
- G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- I. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
- J. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical.

1.04 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
- D. Design Data: Indicate refrigerant pipe sizing.
- E. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- F. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- H. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- I. Project Record Documents: Record actual locations of components and connections.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of experience and approved by manufacturer.

1.06 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide three year manufacturers warranty for solid state ignition modules.
- C. Provide five year manufacturers warranty for heat exchangers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Indoor Units for Ducted Systems
 - 1. Carrier.
 - 2. Trane.
 - 3. Daikin.
 - 4. York.
 - 5. Enviro-Tech.
- B. Indoor Units for Ductless Systems
 - 1. Mitsubishi.
 - 2. Carrier.
 - 3. Trane.
 - 4. Lennox.
 - 5. Daikin.
 - 6. LG.

2.02 SYSTEM DESIGN

- A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
 - 1. Heating: None.
 - 2. Cooling: Outdoor electric condensing unit with evaporator coils in multiple ductless indoor units ("mini-split").
 - 3. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
 - 4. Air Flow Configuration: Horizontal.
 - 5. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
 - 6. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 - 7. Electrical:
 - a. Furnish magnetic contactors.
 - b. Arrange for single point electrical connection.
 - c. Provide field wiring.
 - 8. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 0583 - Wiring Connections.
 - 9. Furnish magnetic contactors.
 - 10. Arrange for single point electrical connection.

2.03 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
 - 1. Location: High-wall.
 - 2. Fan: Cross-flow fan direct driven by a single motor.
 - a. Statically and dynamically balanced and run on a motor with permanently lubricated bearings.
 - b. Fan consists of two speeds:

- 1) High.
- 2) Low.
3. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 2. Condensate Pump: Provide condensate pump when required; pipe drain to floor drain.
- C. Electrical Characteristics:
 1. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 0583 - Wiring Connections.
 2. Furnish magnetic contactors.
 3. Arrange for single point electrical connection.

2.04 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 1. Comply with AHRI 210/240.
 2. Refrigerant: R-410A.
 3. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
 4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.
- B. Compressor: Hermetic, 3600 rpm, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.
 1. Manifold multiple compressors for single joint connection on liquid and suction lines.
- C. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
 1. Condenser Fans: Direct-drive propeller type.
 2. Condenser Fan Motor: Enclosed, 1-phase type, permanently lubricated.
- D. Coil: Air-cooled, aluminum fins bonded to copper tubes.
- E. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
 1. Provide thermostatic expansion valves.
- F. Operating Controls:
 1. Control by room thermostat to maintain room temperature setting.
 2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig and off when pressure drops below 140 psig for operation to 0 degrees F.
 3. Electrical:
 - a. Furnish magnetic contactors.
 - b. Arrange for single point electrical connection.
 - c. Provide field wiring.
- G. Electrical Characteristics:
 1. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 0583 - Wiring Connections.
 2. Furnish magnetic contactors.
 3. Arrange for single point electrical connection.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.

3.02 INSTALLATION

- A. Install in accordance with NFPA 90A and NFPA 90B.
- B. Install gas fired furnaces in accordance with NFPA 54.
- C. Provide vent connections in accordance with NFPA 211.
- D. Install refrigeration systems in accordance with ASHRAE Std 15.
- E. Pipe drain from cooling coils to nearest floor drain.

3.03 FAN COIL UNIT

- A. Installation:
 - 1. Install in location shown on the Drawings. Level unit and secure to structure.
 - 2. Make piping connection and unit installation per manufacturer's recommendations and installation guides.
 - 3. Pipe condensate pan to floor drain per manufacturer's installation guide. Provide minimum 2-inch trap seal on condensate drain connection.
- B. Start-Up:
 - 1. General: Comply with manufacturer's instructions.
 - 2. Install filters before operating unit.
 - 3. Ensure proper refrigerant and airflow before operating unit compressor.

3.04 SPLIT-SYSTEM AIR CONDITIONING UNIT

- A. Installation:
 - 1. Install in location shown on the Drawings. Level unit and secure to structure.
 - 2. Make piping connections and unit installation per manufacturer's recommendations and installation guides.
 - 3. Size and run refrigerant piping between fan coil unit(s) and air-cooled condensing unit(s) per manufacturer's recommendations. Provide traps and double suction and/or discharge risers if recommended by the manufacturer.
 - 4. Insulate refrigerant piping as specified in Section 23 07 00 - Insulation for HVAC.
 - 5. Pipe condensate pan to floor drain per manufacturer's installation guide.
 - 6. Make refrigerant piping connections, install refrigeration accessories, and charge system. Provide additional refrigerant as required for proper operation at design capacities.
- B. Start-Up:
 - 1. General: Comply with manufacturer's instructions.
 - 2. Install filters before operating unit.
 - 3. Insure proper refrigerant and airflow before operating unit compressor.
- C. Provide interconnecting power and control wiring, routed in conduit from the outdoor unit to the indoor unit, and control panel thermostat. Where unit provided requires separate power connections to the indoor and outdoor units provide at no additional cost. Include branch circuit conduit, wiring, circuit breaker, terminations, etc. as required for complete system. Branch circuit serving indoor unit originates in same panelboard serving outdoor unit.
- D. Testing and Adjusting/Performance Test: Except where initial unit operation clearly shows the performance meets or exceeds the requirements, test to show compliance. The manufacturer's representative in the presence of the Engineer to perform tests.

END OF SECTION 23 8126.13

**SECTION 23 8129
VARIABLE REFRIGERANT FLOW HVAC SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable refrigerant volume HVAC system includes:
 - 1. Outdoor/condensing unit(s).
 - 2. Indoor/evaporator units.
 - 3. Branch selector units.
 - 4. Refrigerant piping.
 - 5. Control panels.
 - 6. Control wiring.

1.02 RELATED REQUIREMENTS

- A. Section 23 0800 - Commissioning of HVAC.
- B. Section 23 8130 - Basis of Design VRV Equipment - Daikin.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Alternates: Owner requests a bid Alternate for a system designed and manufactured by a manufacturer other than that listed as the Basis of Design.
 - 1. Alternate systems will be considered only under the terms described for Substitutions in the article MANUFACTURERS in PART 2 of this section.
 - 2. Contractor shall include with Contractor's bid the amount to be deducted from the bid amount if the alternate is accepted by the Owner.

1.04 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ITS (DIR) - Directory of Listed Products.
- E. UL 1995 - Heating and Cooling Equipment.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.06 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Pre-Bid Submittals: For proposed substitute systems/products, as defined in PART 2, and alternate systems/products, as defined above, proposer shall submit all data described in this article, under the terms given for substitutions stated in PART 2.
- C. Product Data: Submit manufacturer's standard data sheets showing the following for each item of equipment, marked to correlate to equipment item markings indicated in Contract Documents:
 - D. Shop Drawings: Installation drawings custom-made for this project; include as-designed HVAC layouts, locations of equipment items, refrigerant piping sizes and locations, condensate piping sizes and locations, remote sensing devices, control components, electrical connections, control wiring connections. Include:
 - 1. Detailed piping diagrams, with branch balancing devices.
 - 2. Condensate piping routing, size, and pump connections.

3. Detailed power wiring diagrams.
 4. Detailed control wiring diagrams.
 5. Locations of required access through fixed construction.
 6. Drawings required by manufacturer.
- E. Design Data:
1. Provide design calculations showing that system will achieve performance specified.
 2. Provide design data required by ASHRAE Std 90.1 I-P.
- F. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- G. Operating and Maintenance Data:
1. Manufacturer's complete standard instructions for each unit of equipment and control panel.
 2. Custom-prepared system operation, troubleshooting, and maintenance instructions and recommendations.
 3. Identification of replaceable parts and local source of supply.
- H. Warranty: Executed warranty, made out in Owner's name.
- I. Specimen Warranty: Copy of manufacturer's warranties.
- J. Project Record Documents: Record the following:
1. As-installed routing of refrigerant piping and condensate piping.
 2. Locations of access panels.
 3. Locations of control panels.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
1. Company that has been manufacturing variable refrigerant volume heat pump equipment for at least 5 years.
 2. Company that provides system design software to installers.
- B. Installer Qualifications: Trained and approved by manufacturer of equipment.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle equipment and refrigerant piping according to manufacturer's recommendations.

1.09 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Compressors: Provide manufacturer's warranty for six (6) years from date of installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Mitsubishi.
- B. Daikin.
- C. LG.
- D. Samsung.

2.02 HVAC SYSTEM DESIGN

- A. System Operation: Heating and cooling, simultaneously.
1. Zoning: Provide heating/cooling selection for each individual indoor/evaporator unit independently of all other units.
 - a. Exception: Where indicated, multiple indoor/evaporator units may be controlled in groups.
 2. Provide a complete functional system that achieves the specified performance based on the specified design conditions and that is designed and constructed according to the equipment manufacturer's requirements.

3. Refrigerant piping sizes are not indicated on drawings.
- B. Operating Temperature Ranges:
 1. Low ambient cooling to 5 degrees F minus 10 degrees F with low ambient kit.
 2. High ambient cooling to 110 degrees F.
 3. Low ambient heating to -4 degrees F -10 degrees F dry bulb.
 4. Simultaneous Heating and Cooling Operating Range: minus 4 degrees F to 60 degrees F dry bulb.
- C. Controls: Provide the following control interfaces:
 1. For Each Indoor/Evaporator Unit: One wall-mounted wired "local" controller, with temperature sensor; locate where indicated.
 2. One central remote control panel for entire system; locate where indicated.
 3. BACNet gateways sufficient to connect all units to building automation system by others; include wiring to gateways.
 4. The building automation system by the VRV manufacturer is not specified in this section. Consult the manufacturer for details.

2.03 EQUIPMENT

- A. All Units: Factory assembled, wired, and piped and factory tested for function and safety.
 1. Refrigerant: R-410A.
 2. Performance Certification: AHRI Certified.
 3. Safety Certification: Tested to UL 1995 by UL or Intertek-ETL, listed in ITS (DIR), and bearing the certification label.
 4. Energy Efficiency: Report EER and COP based on tests conducted at "full load" in accordance with AHRI 210/240 or alternate test method approved by U.S. Department of Energy.
 5. Outdoor Units: Units and their supports designed and installed to resist wind pressures defined in ASCE 7.
- B. System Controls:
 1. Include self diagnostic, auto-check functions to detect malfunctions and display the type and location.
- C. Remote Centralized Control Panel:
- D. Unit Controls: As required to perform input functions necessary to operate system; provided by manufacturer of units.
 1. Provide interfaces to remote control and building automation systems as specified.
 2. Outside air capability.
- E. Wiring:
 1. Control Wiring: 18 AWG, 2-conductor, non-shielded, non-polarized, stranded cable.
 2. Control Wiring Configuration: Daisy chain.
- F. Refrigerant Piping:
 1. Provide three-pipe refrigerant system, including high/low pressure dedicated hot gas, liquid, and suction lines; or two-pipe refrigerant system in accordance with manufacturer recommendations.
 2. Refrigerant Flow Balancing: Provide refrigerant piping joints and headers specifically designed to ensure proper refrigerant balance and flow for optimum system capacity and performance; T-style joints are prohibited.
 3. Insulate each refrigerant line individually between the condensing and indoor units.

2.04 OUTDOOR/CONDENSING UNITS

- A. Outdoor/Condensing Units: Air-cooled DX refrigeration units, designed specifically for use with indoor/evaporator units; factory assembled and wired with all necessary electronic and refrigerant controls; modular design for ganging multiple units.

1. Refrigeration Circuit: Scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
 2. Refrigerant: Factory charged.
 3. Variable Volume Control: Modulate compressor capacity automatically to maintain constant suction and condensing pressures while varying refrigerant volume to suit heating/cooling loads.
 4. Capable of being installed with wiring and piping to the left, right, rear or bottom.
 5. Defrost: Ambient dry and wet bulb temperatures shall be monitored and the outdoor coil temperature shall be adjusted above dew point temperatures to limit defrost operation, so long as heating demand is being met.
 6. Sound Pressure Level: 63 dB(A), measured at 3 feet from front of unit; provide night setback sound control as a standard feature; three selectable sound level steps of 55 dB, 50 dB, and 45 dB, maximum.
 7. Power Failure Mode: Automatically restart operation after power failure without loss of programmed settings.
 8. Provide refrigerant auto-charging feature and refrigerant charge check function.
 9. Safety Devices: High pressure sensor and switch, low pressure sensor/switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 10. Provide refrigerant sub-cooling to ensure the liquid refrigerant does not flash when supplying to us indoor units.
 11. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.
 12. Controls: Provide contacts for electrical demand shedding.
- B. Unit Cabinet: Weatherproof and corrosion resistant; galvanized steel panels coated with baked enamel finish.
1. Designed to allow side-by-side installation with minimum spacing.
 2. Access and service panels to all internal components.
- C. Fans: One or more direct-drive propeller type, vertical discharge, with multiple speed operation.
1. External Static Pressure: Factory set at 0.12 in WG, minimum.
 2. Indoor Mounted Air-Cooled Units: External static pressure field set at 0.32 in WG, minimum; provide for mounting of field-installed ducts.
 3. Fan Motors: Factory installed; variable speed; permanently lubricated bearings; inherent protection; fan guard.
- D. Condenser Coils: Copper tubes expanded into aluminum fins to form mechanical bond.
- E. Compressors: Scroll type, hermetically sealed, variable speed inverter-driven and fixed speed in combination to suit total capacity; minimum of one variable speed, inverter driven compressor per condenser unit; minimum of two compressors per condenser unit; capable of controlling capacity within range of 6 percent to 100 percent of total capacity.
1. Variable Speed Control: Capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure; high/low pressures calculated by samplings of evaporator and condenser temperatures, with compressor capacity adjusted to eliminate deviation from target value by changing inverter frequency or on/off setting of fixed speed compressors.
 2. Multiple Condenser Modules: Balance total operation hours of compressors by means of duty cycling function, providing for sequential starting of each module at each start/stop cycle, completion of oil return, and completion of defrost, or every 8 hours.

3. Failure Mode: In the event of compressor failure, operate remaining compressor(s) at proportionally reduced capacity; provide microprocessor and associated controls specifically designed to address this condition.
4. Provide each compressor with crankcase heater, high pressure safety switch, and internal thermal overload protector.
5. Provide oil separators and intelligent oil management system.
6. Provide accessories and kits required for a complete installation including field connection of units with multiple frames.

2.05 BRANCH SELECTOR UNITS

- A. Branch Selector Units: Concealed boxes designed specifically for this type of system to control heating/cooling mode selection of downstream units; consisting of electronic expansion valves, subcooling heat exchanger, refrigerant control piping and electronics to facilitate communications between unit and main processor and between branch unit and indoor/evaporator units.
 1. Two-Pipe System:
 - a. General:
 - 1) Galvanized steel finish.
 - 2) Completely factory assembled, piped, and wired.
 - 3) Each unit run tested at the factory.
 - 4) Mount indoors and operate so that different zones served by each controller can be in heating and cooling mode simultaneously.
 - b. Cabinet:
 - 1) House a liquid-gas separator and multiple refrigeration control valves.
 - 2) One sub-cooling heat per port.
 - 3) Casing: Fabricated of galvanized steel.
 - c. Refrigerant Valves:
 - 1) Furnish unit with multiple two position refrigerant valves.
 - 2) Circuit: Two-position liquid line valve and a two-position suction line valve.
 - 3) When connecting higher capacity indoor units, join two branch circuits joined together at the branch controller to deliver an appropriate amount of refrigerant the two refrigerant valves operate simultaneously.
 - 4) Linear electronic expansion valves used to control the variable refrigerant flow.
 - 5) Isolation valves shall be provided on all refrigerant pipes to allow servicing without interrupting the overall system operation or evacuating the entire system refrigerant charge.
 - 6) Provide a minimum of one spare port for future use.
 - d. Integral Drain Pan: Where required, provide integral condensate pan and drain.
 - e. Condensate Pump:
 - 1) Provide internal factory-mounted condensate pump with hard-wired electrical connection.
 - 2) Provide external condensate pump with hard-wired electrical connection when required.
 - 3) Pipe drain to floor drain.
 - f. Electrical:
 - 1) Furnish starters and contactors.
 - 2) Arrange for single point electrical connection.

2.06 INDOOR/EVAPORATOR UNITS

- A. All Indoor/Evaporator Units: Factory assembled and tested DX fan-coil units, with electronic proportional expansion valve, control circuit board, factory wiring and piping, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 - 1. Refrigerant: Refrigerant circuits factory-charged with dehydrated air, for field charging.
 - 2. Temperature Control Mechanism: Return air thermistor and computerized Proportional-Integral-Derivative (PID) control of superheat.
 - 3. Dehumidification Function: In conjunction with wall-mounted wired remote controller.
 - 4. Coils: Direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
 - a. Flare connections to refrigerant piping.
 - 5. Fans: Direct-drive motor with permanently lubricated and sealed bearings, with statically and dynamically balanced impellers; high and low speeds unless otherwise indicated; motor thermally protected.
 - 6. Return Air Filter: Washable long-life net filter with mildew proof resin, unless otherwise indicated.
 - a. Where high efficiency filters are indicated, provide air filter rack.
 - 7. Condensate Drainage: Built-in condensate drain pan with PVC drain connection.
 - a. Units With Built-In Condensate Pumps: Provide condensate safety shutoff and alarm.
 - b. Units Without Built-In Condensate Pump: Provide built-in condensate float switch and wiring connections.
- B. Concealed-In-Ceiling Units: Ducted horizontal discharge and return; high static galvanized steel cabinet.
 - 1. Return Air Filter: High efficiency, MERV 8.
 - 2. Provide external static pressure switch adjustable for high efficiency filter operation
 - 3. Condensate Pump: Built-in, with lift of 20 inches, minimum.
- C. Wall Surface-Mounted Units: Finished white casing, with removable front grille; wall mounting plate; condensate drain pan.
 - 1. Airflow Control: Auto-swing louver that closes automatically when unit stops; set using remote controller; upon restart, discharge angle defaulting to same angle as previous operation.
 - 2. Condensate Pump: Built-in, concealed, with lift of 20 inches, minimum.
 - 3. Condensate Drain Connection: Back, with piping concealed in wall.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in location shown on the Drawings. Level unit and secure to structure. Provide secondary structural base where required to attached to structure. Provide vibration isolators where indicated.
- B. Make piping connections and unit installation per manufacturer's recommendations and installation guides.
- C. Size and run refrigerant piping between fan coil unit(s), branch circuit controller(s) and condensing unit(s) per manufacturer's recommendations.
- D. Insulate refrigerant piping as specified in Section 23 0719 - HVAC Piping Insulation.
- E. Pipe coil drain pan to floor drain per manufacturers installation guide.
- F. Provide secondary drain protection via a sensor in the drain pain overflow. Field wire interlock to shut down the unit upon sensing of moisture.
- G. Make refrigerant piping connections, install refrigeration accessories, and charge system. Provide additional refrigerant as required for proper operation at design capacities.
- H. Provide interconnecting power and control wiring.

3.02 CONTROLS

- A. Provide devices, materials, equipment, software, wiring, interconnecting power, labor, and engineering necessary to achieve the Sequences of Operation described in the documents.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide manufacturer's field representative to inspect installation prior to startup.

3.04 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform system startup.
- B. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.
- C. Adjust equipment for proper operation within manufacturer's published tolerances.
- D. Install filters before operating unit.

3.05 CLEANING

- A. Clean exposed components of dirt, finger marks, and other disfigurements.

3.06 COMMISSIONING

- A. See Section 01 9113 - General Commissioning Requirements for commissioning requirements.
- B. Perform commissioning as specified in Section 23 0800.
- C. Perform the following Functional Tests:
- D. Replace components not functioning properly.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstrate proper operation of equipment to Owner's designated representative.
- D. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- E. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

3.08 PROTECTION

- A. Protect installed components from subsequent construction operations.
- B. Replace exposed components broken or otherwise damaged beyond repair.

END OF SECTION 23 8129

**SECTION 23 8216
AIR COILS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water heating coils.

1.02 RELATED REQUIREMENTS

- A. Section 23 0719 - HVAC Piping Insulation.
- B. Section 23 2114 - Hydronic Specialties.
- C. Section 23 3100 - HVAC Ducts and Casings: Installation of duct coils.

1.03 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- B. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Aerofin Corporation
- B. Luvata UK Ltd
- C. Trane, a brand of Ingersoll Rand
- D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 WATER HEATING COILS

- A. Tubes: 5/8 inch OD seamless copper arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
- B. Fins: Aluminum.
- C. Casing: Die formed channel frame of 16 gauge, 0.0598 inch galvanized steel with mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.
- D. Headers: Seamless copper tube with silver brazed joints.
- E. Testing: Air test under water to 200 psi for working pressure of 200 psi and 220 degrees F.
- F. Configuration: Drainable, with threaded plugs for drain and vent.
- G. Fin Spacing: 8 fins per inch.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.

- B. Install in ducts and casings in accordance with SMACNA (DCS).
 - 1. Support coil sections independent of piping on steel channel or double angle frames and secure to casings.
 - 2. Arrange supports to avoid piercing drain pans.
 - 3. Provide airtight seal between coil and duct or casing.
 - 4. Refer to Section 23 3100.
- C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- D. Install coils level. Install cleanable tube coils with 1:50 pitch.
- E. Make connections to coils with unions and flanges.
- F. Hydronic Coils:
 - 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 - 2. Provide manual air vents at high points complete with stop valve.
 - 3. Ensure water coils are drainable and provide drain connection at low points.

END OF SECTION 23 8216

**SECTION 23 8300
RADIANT HEATING AND COOLING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic radiant panel heaters.

1.02 RELATED REQUIREMENTS

- A. Section 23 0716 - HVAC Equipment Insulation.
- B. Section 23 0719 - HVAC Piping Insulation.
- C. Section 23 0913 - Instrumentation and Control Devices for HVAC.
- D. Section 23 2113 - Hydronic Piping.
- E. Section 23 2114 - Hydronic Specialties.
- F. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 138 - Method of Testing for Rating Ceiling Panels for Sensible Heating and Cooling.
- B. ASTM B75/B75M - Standard Specification for Seamless Copper Tube.
- C. DIN EN 14037-2 - Free Hanging Heating and Cooling Surfaces for Water with a Temperature Below 120 Degrees C - Part 2: Pre-Fabricated Ceiling Mounted Radiant Panels for Space Heating - Test Method for Thermal Output.
- D. DIN EN 14037-3 - Free Hanging Heating and Cooling Surfaces for Water with a Temperature Below 120 Degrees C - Part 3: Prefabricated Ceiling Mounted Radiant Panels for Space Heating - Rating Method and Evaluation of Radiant Thermal Output.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 23 0500 - Common Work Results for HVAC for submittal procedures.
- B. Product Data: Provide catalog sheets indicating general assembly, dimensions, weights, materials, and certified performance ratings.
- C. Shop Drawings: Indicate general assembly, dimensions, weights, and materials.
- D. Manufacturer's Installation Instructions: Indicate installation instructions and recommendations.
- E. Field Quality Control Submittals: Indicate test reports and inspection reports.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, installation instructions, maintenance and repair data, and parts listings.
- G. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- H. Maintenance Data:
 - 1. Include repair methods and parts list of components.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- C. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 HYDRONIC RADIANT PANEL HEATERS

- A. Manufacturers:
 - 1. Barcol-Air USA Ltd.
 - 2. Price Industries.
 - 3. TWA Panel Systems, inc.
- B. Modular Radiant Ceiling Panels: Heat sinks located behind panel, transfer heat between copper tubes and panel face, and radiate heat to zone.
 - 1. Water Tubes:
 - a. ASTM B75/B75M copper tubing, 1/2 inch minimum nominal diameter.
 - b. Water Connections:
 - 1) Same end only.
 - 2) Suitable for solder, compression fittings, push-on fittings, or threaded connection.
 - 3) Protect with removable seals. Prevent introduction of dirt and dust during shipping.
 - 2. Heat Sink Construction:
 - a. Mechanically fasten extruded aluminum and copper pipe to heat sink.
 - b. Provide non-hardening heat transfer paste between tubing, heat sink, and panel.
 - 3. Panel Face: Construct of minimum 18 gauge, 0.0403 inch thick aluminum.
 - 4. Finish:
 - a. Apply manufacture's standard finish.
 - b. Color: As selected by Architect from manufacturer's standard range.
 - c. Maintain optimal radiative properties, durability, and cleanability.
 - 5. Water Pressure Drop and Heating Output Data: Derive from factory testing in accordance with ASHRAE Std 138 or DIN EN 14037, Parts 2 and 3.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Hydronic and Electric Radiant Ceiling Panel Heaters:
 - 1. Examine areas to receive radiant heating units for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 2. Examine roughing-in for hydronic piping connections to verify actual locations prior to installation.
 - 3. Ensure surfaces in contact with radiant heating panels are free of burrs and sharp protrusions.
 - 4. Ensure surfaces are level and plumb.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Hydronic and Electric Radiant Ceiling Panel Heaters:
 - 1. Install level and plumb.
 - 2. Suspend from structure.
 - 3. Support in grid-type suspended ceiling using grid as support element as follows:

- a. Install a minimum of four ceiling support system rods or wires for each panel, located not more than 6 inches from panel corners.
 - b. Fasten support clips to panel and to ceiling grid members at or near each panel corner with clips designed for the application.
 - c. For panels of sizes less than ceiling grid, install as indicated on reflected ceiling plan(s) or center of acoustical panel, and support panels independently with at least two 3/4 inch metal channels spanning and secured to ceiling tees.
 - d. Install at least one independent support rod or wire from structure to tab on panel with breaking strength of the weight of panel at a safety factor of 3.
- 4. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
 - 5. See Section 23 2113 and Section 23 2114 for additional requirements.
- C. Hydronic Radiant Panel Heaters: Consult manufacturer's installation manual for panels not installed in ceiling systems.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide manufacturer's field representative to test, inspect, instruct, and observe.
- C. Hydronic Radiant Ceiling Panel Heaters:
- 1. Inspect for damage to finish.
 - 2. Repair damaged finish to match original finish.
 - 3. Perform the following field tests, inspections, and prepare test reports:
 - a. Leak Test:
 - 1) After installation, fill water tubes, and test for leaks.
 - 2) Repair leaks and retest until no leaks exist.
 - b. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - c. Test and adjust controls and safeties.
 - 4. Manufacturer's Field Service:
 - a. Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing.
 - b. Report any findings in writing.
 - 5. Remove and replace damaged and malfunctioning controls and equipment and retest as specified above.
- D. Hydronic Radiant Heating Piping:
- 1. Prepare radiant heating piping for testing as follows:
 - a. Open all isolation valves and close bypass valves.
 - b. Open and verify operation of zone control valves.
 - c. Flush with clean water and clean strainers.
 - 2. Perform the following tests and inspections with the assistance of a factory authorized service representative:
 - a. Leak Test:
 - 1) After installation, charge system and test for leaks.
 - 2) Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig.
 - 3) Repair leaks and retest until no leaks exist.
 - b. Test and adjust controls and safeties.
 - c. Replace damaged and malfunctioning controls and equipment.
 - 3. Execute, complete, and pass required radiant-heating piping tests and inspections to accept installed piping.

4. Prepare test and inspection reports.
5. Protect hydronic piping system from damage during construction.

3.04 CLEANING

- A. Radiant Ceiling Panel Heaters: Remove paint splatters, other spots, dirt, and debris.

3.05 CLOSEOUT ACTIVITIES

- A. Demonstrate Operation of Controls for the following Equipment:
 1. Hydronic Radiant Ceiling Panel Heaters.
 2. Electric Radiant Ceiling Panel Heaters.

3.06 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.
- B. Outdoor Equipment: Touch-up, repair, or replace damaged products before Date of Substantial Completion.

END OF SECTION 23 8300

**SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL**

PART 1 GENERAL

1.01 SUMMARY

- A. The intent of this Division's Specifications and Drawings is to provide a complete and workable facility, with complete systems as required by applicable codes, as indicated, and as specified.
- B. Provide a complete and workable facility with complete systems that comply with the requirements of the state codes, local codes, and other authorities having jurisdiction. Include design, labor and materials required to install, test and place into operation the systems as called for in the Contract Documents and according to applicable codes and regulations.
- C. Specifications and the accompanying Drawings are complementary and what is called for by one is as binding as if called for by both.
- D. The General and Supplemental Conditions apply to this Division, including but not limited to:
 - 1. Drawings and Specifications.
 - 2. Public ordinances and permits.
 - 3. Payments and fees required by governing authorities for work of this Division.
- E. The Drawings that accompany this Division are diagrammatic. They do not show every offset, bend, tee, or elbow, which may be required to install work in the space provided and avoid conflicts with other construction.
- F. Provide connections, raceway, wiring, breakers and installation required for systems specified, as required by the manufacturers installation documents, and for complete system functionality.
- G. Offsets and transitions are to be assumed at a minimum at each crossing of services, structural penetrations through shear walls or beams, structural grids, where ceiling heights are restricted, and at piping and conduit mains.
- H. Follow the Drawings as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions, and without additional cost to the Owner. Significant deviations from the routing shown on the drawings is subject for approval prior to installation. The right is reserved by the design team to make reasonable changes in locations of system components prior to roughing-in, without cost impact.
- I. Verify dimensions, field conditions, quantities, and measurements prior to installing work.
- J. Work done under this Division of the specifications includes the furnishing of labor, material, equipment, and tools required for the complete installation of the work indicated on the Drawings or as specified herein.
- K. Work installed contrary to Drawings and Specifications is subject to change as directed by the Owner and no extra compensation will be allowed for making those changes.

1.02 PRICE AND PAYMENT PROCEDURES

- A. Allowances
 - 1. Comply with Division 01, General Requirements.
- B. Alternates
 - 1. Comply with Division 01, General Requirements.
 - 2. Refer to Drawings for detailed information relating to the appropriate alternates.

1.03 RELATED REQUIREMENTS

- A. Division 00, Procurement and Contracting Requirements
- B. Division 01, General Requirements
- C. Division 07, Thermal and Moisture Protection
- D. Division 08, Openings
- E. Division 09, Finishes

- F. Division 11, Equipment
- G. Division 21, Fire Suppression
- H. Division 22, Plumbing
- I. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- J. Division 26, Electrical
- K. Division 28, Electronic Safety and Security
- L. Division 31, Earthwork
- M. Division 33, Utilities

1.04 REFERENCES

- A. References, Codes and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 27 Sections and those listed in this section.
- B. Codes and Standards:
 - 1. Comply with applicable sections of the most recent editions and addenda of following for interior and exterior installations.
 - 2. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
 - a. IBC - International Building Code
 - b. NEC/NFPA 70 - National Electrical Code
 - c. ANSI/IEEE C2 - National Electrical Safety Code
 - d. ANSI - American National Standards Institute
 - e. NEMA - National Electrical Manufacturers Association
 - f. NFPA - National Fire Protection Association
 - g. NECA - National Electrical Contractors Association
 - h. NETA - National Electrical Testing Association
 - i. IEEE - Institute of Electrical and Electronic Engineers
 - j. UL - Underwriters Laboratories
 - 3. State of Oregon:
 - a. OAR - Oregon Administrative Rules
 - b. OESC - Oregon Electrical Specialty Code
 - c. OFC - Oregon Fire Code
 - d. OSSC - Oregon Structural Specialty Code
 - e. OEESC - Oregon Energy Efficiency Specialty Code

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
 - 1. Review Drawings of other trades and Owner provided equipment to avoid conflicts.
 - 2. Report potential conflicts to Architect, provide resolution prior to rough-in.
 - 3. Architectural Drawings take precedence regarding exact placement of system components and equipment.
 - 4. Verify the physical dimensions of equipment to fit the space available.
 - 5. Coordinate access routes through the construction, equipment move-in planning, and provide required equipment, transport and services necessary to facilitate installation of equipment.
 - 6. Where connections are required for equipment provided as Work of other Divisions, coordinate rough in and connection requirements for that equipment with its supplier and installer prior to commencing work.
 - 7. Notify Architect of any discrepancies between the actual rough in and connection requirements, and those identified on Drawings for resolution prior to installation.
 - 8. Coordinate underground work with other trades working on the site.

- a. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained.
- 9. Coordinate installation of required supporting devices and set sleeves in architectural and structural components as they are constructed.
- 10. Coordinate location of access panels and doors for items concealed behind finished surfaces with Architect.
- 11. Coordinate sleeve selection and application with firestopping specified elsewhere.
- 12. Finishes: Coordinate with Architect, finish to match surrounding surfaces.
- 13. Layout Drawings:
 - a. The documents represent the design intent for the systems on the project. They do not indicate means and methods.
 - b. For projects with existing conditions and renovations, the documents do not represent the installed systems or installations.
 - c. Equipment arrangement shown on Drawings is diagrammatic to indicate general equipment sizing and spatial relationship. Include, as part of distribution equipment submittal, a scaled floor plan, which includes equipment shown with their submitted sizes. Include feeder conduit routing, both aboveground and underground, including termination points at equipment. Submit for Engineer's review prior to commencing work.
 - d. Provide additional wiring details at switchboards, motor control centers, and other areas where work is of sufficient complexity to warrant additional detailing for coordination.
 - e. Equipment layouts will comply with all code required clearance and working areas and any additional required maintenance clearance and access areas.
 - f. Submit layout drawings for approval prior to commencing field installation.
- 14. Arrange raceways, wiring, and equipment to permit ready access to switches, motors, and control components.
 - a. Keep doors and access panels clear.
- 15. Coordinate electrical, telephone, and other utility services with the appropriate serving utility.
 - a. No additional compensation will be allowed to the Contractor for connection fees or additional work or equipment required by the serving utility, but not covered in the Drawings or Specifications.
- B. Sequencing
 - 1. The electrical work of this project is complex in nature and has an inherent sequence, which may not be readily discernable.
 - 2. Implement construction sequences to be the least impactful possible to current facilities and services. Where current services are required to be maintained, provide necessary equipment such temporary generators and all connections to minimize downtime and cutovers.
 - 3. Submit construction sequences for review and coordinate sequencing with other trades.
 - 4. Construction sequences may be provided as part of the design documents. Where provided, review, provide comments and input. The sequences indicate the general natural of the work are provided as a guide. Provide further development of the construction sequences as required to perform the work.
- C. Permits
 - 1. Obtain permits and inspections for the installation of work and pay charges required. Deliver certificates of inspection issued by authorities to the Owner.

1.06 SUBMITTALS

- A. General Submittal Requirements:
 - 1. Refer to Division 00 and Division 01 for general submittal requirements.
 - 2. Requirements set forth in this Section pertain to all specifications included in this Division of work.
- B. Pre-Bid Submittal Requirements
 - 1. Submit Questions and Substitution Requests before the Questions deadline, defined in Division 00 and Division 01.
- C. Bid Submittal Requirements
 - 1. Refer to individual Division sections for specific requirements due with Bid.
- D. Contractor Responsibilities:
 - 1. Provide submittals one time and organized in proper order.
 - 2. Indicate deviations from Drawings and Specifications explicitly in the submittals. Failure to comply will void review automatically.
- E. Submittal Schedule:
 - 1. General:
 - a. Submit a schedule that is coordinated with the project construction schedule.
 - b. Allow for time required for review of submittals, making corrections/revisions to submittals, ordering, manufacturing, fabrication, and delivery.
 - 2. Submittal Schedule to include the following for each submittal as a minimum:
 - a. Identify submittal by specification section number and title.
 - b. Date the item will be submitted. Arrange items in chronological order by scheduled date for first submittal.
 - c. Identify critical submittals and long lead items explicitly.
 - d. Submittal Category:
 - 1) Product Data
 - 2) Coordination Drawings
 - 3) Shop Drawings
 - 4) Samples
 - 5) Construction Sequences
 - 6) Certificates
 - 7) Delegated Design Submittals
 - 8) Test and Evaluation Reports
 - 9) Manufacturers' Instructions
 - 10) Source Quality Control
 - 11) Site Quality Control
 - 12) Manufacturer Reports
 - 13) Sustainable Design
 - 14) Qualification Statements
 - e. Closeout Submittal Category:
 - 1) Maintenance Contracts
 - 2) Operations and Maintenance Data
 - 3) Bonds
 - 4) Warranty Documentation
 - 5) Final Test and Evaluation Reports
 - 6) Record Documentation
 - 7) Demonstration and Training
 - 8) Sustainable Design Closeout
 - 9) Software

F. Product Data:

1. General:

- a. Assemble complete submittal package for this Division into a single submittal.
 - 1) Partial submittals will not be accepted.
- b. Submit product data on following equipment for review:
 - 1) Equipment scheduled on Drawings.
 - 2) Equipment requiring electrical connections or connections by other trades.
 - 3) As required by each specification section or by notes on the Drawings.

2. Format:

- a. Electronic: Submit electronic copies for Work of this Division in PDF format.
 - 1) Include a complete index in the original submittal.
 - (a) Incorporate links enabling navigation to each item.
 - (b) Identify with each item filed under a folder and labeled with its respective specification section number, Article, and paragraph.
 - 2) Provide cover sheet for each applicable section number.
- b. Hard Copy: Submit copies for Work of this Division in a 3-ring loose leaf binder.
 - 1) Include a complete index in the original submittal.
 - (a) Identify with each item filed under a tab and labeled with its respective specification section number, Article, and paragraph
 - 2) Provide cover sheet for each applicable section number.

3. Include for each item as a minimum:

- a. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified.
- b. Manufacturer's detailed shop drawings including clearances required.
- c. Manufacturer's detailed specifications.
- d. Manufacturer's data sheets including capacities, operating speeds, power requirements, design and operating conditions, performance curves, characteristics scheduled or described on the Drawings, and similar data.
- e. List the name of the motor manufacturer and service factor for each piece of equipment.
- f. Indicate equipment operating weights including bases and weight distribution at support points.
- g. Wiring diagrams showing factory installed wiring.

G. Coordination Drawings:

1. General:

- a. Assemble complete submittal package for the project into a minimum of two submittals.
 - 1) Coordination Drawings - Below Grade
 - 2) Coordination Drawings - Above Grade
- b. Prepare project-specific information, drawn accurately to scale.
- c. Submit coordination drawings for review prior to beginning fabrication.
- d. Sheet Size: Match sheet size of Construction Drawings.
- e. Prepare in three-dimensional format utilizing the same digital data software program, version, and operating system utilized to develop the Construction Drawings.

2. Format:

- a. Electronic: Submit electronic copies in PDF format.
- b. Hard Copy: Submit copies in a 3-ring loose leaf binder.

3. Include as a minimum:

- a. Color code and overlay shop drawings for each trade:
 - 1) Structural
 - 2) Civil

- 3) Ceiling Systems
 - 4) HVAC Equipment
 - 5) HVAC Ductwork
 - 6) HVAC Piping
 - 7) Plumbing Equipment
 - 8) Plumbing Piping
 - 9) Fire Suppression
 - 10) Lighting
 - 11) Electrical Power
 - 12) Communications
 - 13) Electronic Safety and Security
- b. Complete floor plans to a minimum of 1/4-inch equals 1-foot scale.
 - c. Mechanical rooms to a minimum of 1/2-inch equals 1-foot scale.
 - d. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
- H. Shop Drawings:
- 1. General:
 - a. Assemble complete submittal package for this Division into a single submittal.
 - 1) Partial submittals will not be accepted.
 - b. Prepare project-specific information, drawn accurately to scale.
 - c. Prepare new Shop Drawings by Contractor and not reproductions or tracings of Engineer's Design Drawings.
 - d. Submit shop drawings for review prior to beginning fabrication.
 - 1) Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.
 - e. Sheet Size: Match sheet size of Construction Drawings.
 - f. Prepare in three-dimensional format utilizing the same digital data software program, version, and operating system utilized to develop the Construction Drawings.
 - 2. Format:
 - a. Electronic: Submit electronic copies for Work of this Division in PDF format.
 - 1) Include a complete index in the original submittal.
 - (a) Incorporate links enabling navigation to each item.
 - (b) Identify with each item filed under a folder and labeled with its respective specification section number, Article and paragraph.
 - b. Hard Copy: Submit copies for Work of this Division in a 3-ring loose leaf binder.
 - 1) Include a complete index in the original submittal.
 - (a) Identify with each item filed under a tab and labeled with its respective specification section number, Article and paragraph.
 - 3. Include as a minimum:
 - a. Complete floor plans to a minimum of 1/4-inch equals 1-foot scale.
 - b. Mechanical, Electrical, and Technology rooms to a minimum of 1/2-inch equals 1-foot scale.
 - c. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
 - d. Fabricated equipment to a minimum of 1/4-inch equals 1-foot scale.
- I. Samples
- 1. Refer to individual Division sections for Submittal requirements.
- J. Certificates
- 1. Refer to individual Division sections for Submittal requirements.
- K. Delegated Design Submittals
- 1. Refer to individual Division sections for Submittal requirements.

- L. Test and Evaluation Reports
 - 1. Refer to individual Division sections for Submittal requirements.
- M. Manufacturers' Instructions
 - 1. Refer to individual Division sections for Submittal requirements.
- N. Source Quality Control Submittals
 - 1. Refer to individual Division sections for Submittal requirements.
- O. Site Quality Control Submittals
 - 1. Refer to individual Division sections for Submittal requirements.
- P. Manufacturer Reports
 - 1. Refer to individual Division sections for Submittal requirements.
- Q. Qualification Statements
 - 1. Refer to individual Division sections for Submittal requirements.

1.07 CLOSEOUT SUBMITTALS

- A. Maintenance Contracts
 - 1. Refer to individual Division sections for Submittal requirements.
- B. Operations and Maintenance Data
 - 1. General:
 - a. Assemble complete submittal package for this Division into a single submittal.
 - 1) Partial submittals will not be accepted.
 - b. Submit when the work is substantially complete.
 - c. Submit manufacturer's operation and maintenance instruction manuals and parts lists for review on following equipment:
 - 1) Equipment scheduled on Drawings.
 - 2) Equipment requiring electrical connections or connections by other trades.
 - 3) As required by each specification section or by notes on the Drawings.
 - 2. Format:
 - a. Electronic: Submit electronic copies for Work of this Division in PDF format.
 - 1) Include a complete index in the original submittal.
 - (a) Incorporate links enabling navigation to each item.
 - (b) Identify with each item filed under a folder and labeled with its respective specification section number, Article and paragraph.
 - b. Hard Copy: Submit copies for Work of this Division in a 3-ring loose leaf binder.
 - 1) Include a complete index in the original submittal.
 - (a) Identify with each item filed under a tab and labeled with its respective specification section number, Article and paragraph.
 - 3. Include for each item as a minimum:
 - a. Include name and contact information for location of source parts and service for each piece of equipment.
 - b. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified.
 - c. Manufacturer's operation and maintenance instruction manuals.
 - d. Manufacturer's detailed shop drawings including clearances required.
 - e. Manufacturer's detailed specifications.
 - f. Manufacturer's data sheets including capacities, operating speeds, power requirements, design and operating conditions, performance curves, characteristics scheduled or described on the Drawings, and similar data.
 - g. List the name of the motor manufacturer and service factor for each piece of equipment.

- h. Indicate equipment operating weights including bases and weight distribution at support points.
 - i. Wiring diagrams showing factory installed wiring.
- C. Bonds
 - 1. Refer to individual Division 00 and Division 01 sections for Submittal requirements.
- D. Warranty Documentation
 - 1. Refer to individual Division 00 and Division 01 sections for Submittal requirements.
- E. Final Test and Evaluation Reports
 - 1. Refer to individual Division sections for Submittal requirements.
- F. Record Documentation
 - 1. Shop Drawings
 - a. Shop drawings updated with as-built information and submitted as the record drawing set.
 - 2. Record Drawings
 - a. General:
 - 1) Provide drawings with notations reflecting the as-built conditions.
 - 2) Notations to include any additions to or variations from the construction documents provided as part of the BIM coordination, RFIs, ASIs, Owner Changes, and Field Coordination.
 - 3) Prepare project-specific information, drawn accurately to scale.
 - 4) Provide project specific title block.
 - b. Sheet Size: Match sheet size of Construction Drawings.
 - c. Prepare in two-dimensional format utilizing the same digital data software program, version, and operating system utilized to develop the Construction Drawings.
 - d. Format:
 - 1) Electronic: Submit electronic copies of record drawings for Work of this Division in PDF format.
 - (a) Include a complete index in the original submittal.
 - (b) Incorporate links enabling navigation to each item.
 - (c) Identify with each item filed under a folder and labeled with its respective specification section number, Article and paragraph.
 - 2) Hard Copy: Submit copies of record drawings for Work of this Division in a 3-ring loose leaf binder.
 - (a) Include a complete index in the original submittal.
 - (b) Identify with each item filed under a tab and labeled with its respective specification section number, Article and paragraph.
- G. Demonstration and Training
 - 1. Training Plan:
 - a. Submit outline of instructional program for demonstration and training.
 - b. Include the following:
 - 1) List of training modules.
 - 2) Schedule of proposed dates, times, length of instruction time.
 - 3) Instructors' names for each training module.
 - 4) Learning objective and outline for each training module.
 - 2. Training Video Recordings:
 - a. Identification: On each copy, provide an applied label with the following information:
 - 1) Name of Project.
 - 2) Name and address of videographer.
 - 3) Name of Architect.
 - 4) Name of Contractor or Construction Manager.

- H. Sustainable Design Closeout Documentation
 - 1. Refer to individual Division sections for Submittal requirements.
- I. Software
 - 1. Refer to individual Division sections for Submittal requirements.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts
 - 1. Refer to individual Division sections for Submittal requirements.
- B. Extra Stock Materials
 - 1. Refer to individual Division sections for Submittal requirements.
- C. Tools
 - 1. Refer to individual Division sections for Submittal requirements.

1.09 QUALITY ASSURANCE

- A. Regulatory Requirements
 - 1. Products and equipment are prohibited from containing pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
 - 2. General:
 - a. Conform Work and materials to requirements of the local, State, and Federal authorities having jurisdiction and other applicable laws and regulations.
 - b. Where codes or standards are referenced, the applicable portions apply.
 - c. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, apply the more stringent.
 - d. Should any change in drawings or specifications be required to comply with governing regulations, notify the Architect prior to submitting bid.
 - e. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, skillful and well-executed manner by competent workers. Provide a competent, experienced full-time Superintendent who is authorized to make decisions on behalf of the Contractor.
 - f. The Architect or Architect's Representative may conduct unannounced field reviews of any work completed or in progress during the Contractor's working hours. A report will be issued to the Contractor if the field review of the systems construction has revealed elements of the work which are inconsistent with the Contract Documents. All items in the report are to be addressed in writing by the Contractor within two (2) weeks and corrections in the field made as directed.
- B. Apparatus:
 - 1. Build and install to deliver full rated capacity at the efficiency for which it was designed.
 - 2. Provide entire system and apparatus that operate at full capacity without objectionable noise or vibration.
- C. Alignment
- D. Install panels, cabinets, and equipment level and true. Provide housekeeping pads and curbs accounting for floor or roof slope.
- E. Install distribution equipment and electrical enclosures fitted neatly, without gaps, openings, or distortion.
 - 1. Properly and neatly, close unused openings with approved devices.
 - 2. Fit surface panels, devices, and outlets with neat, appropriate, trims, plates, or covers without overhanging edges, protruding corners, or raw edges.
- F. Materials and Equipment:

1. Provide new work of good quality, free of faults and defects and in conformance with the Construction documents.
 2. Each piece of equipment furnished will meet the detailed requirements of the Drawings and Specifications and will be suitable for the installation shown. Equipment not meeting the requirements will not be acceptable, even though specified by name along with other manufacturers.
 3. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
 4. Furnish materials and equipment of size, make, type, and quality herein specified.
 5. Equipment scheduled by performance or model number is considered as the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the Contractor is responsible for changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements, or any other differences which impact the project.
- G. Workmanship:
1. General: Install materials in a neat and professional manner.
 2. Manufacturer's Instructions:
 - a. Follow manufacturer's directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division Specifications, obtain clarification before starting work.
- H. Noise Control
1. Do not install contactors, transformers, starters, and similar noise-producing devices on walls that are common to occupied spaces, unless otherwise indicated.
 - a. Where such devices are indicated to be mounted on walls common to occupied spaces, use shock mounts, or otherwise isolate them to prevent the transmission of noise to the occupied spaces.
 2. Ballasts, contactors, starters, transformers, and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and be replaced.
- I. Cutting and Patching:
1. Provide cutting, patching, and repairing for the proper installation and completion of the work specified in this Division by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work. This work includes but is not limited to plastering, masonry work, concrete work, carpentry work, and painting.
 2. Make additional openings required in building construction by drilling or cutting. Use of jackhammer is specifically prohibited.
 3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
 4. Do not pierce beams, columns or structure members without approval from the Architect and structure engineer, and then only as directed.
 5. New or existing work cut or damaged will be restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces will be repaired, refinished, and left in condition existing prior to commencement of work.
- J. Visibly damaged goods are to be returned to the supplier and replaced at no additional cost to the Owner.
- K. Contractor Responsibility:
1. Examination of building and site responsibility:

- a. Examine site and building prior to installation to determine conditions affecting the scope of work.
 - b. Contact Owner representative for arrangements.
 - 2. Respect and protect the privacy and confidentiality of Owner, its employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the State and Owner policies.
 - 3. Total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications.
 - 4. Specified systems installed under the direction of a qualified Contractor. Qualification requirements include submittal by the Contractor to the Architect of the following:
 - a. Have experience with three or more installations of systems comparable in size, complexity, type, and design as specified herein.
 - b. Perform each of these installations satisfactorily for at least one year after final acceptance by the user. Include the names, locations, and point of contact for these installations as a part of the initial submittal documentation.
 - c. List of previous projects of this scope, size, and nature, including names and sizes of projects, description of work, time of completion, and names of contact persons for reference.
- L. Manufacturers
 - 1. Equipment in these Sections are the standard products of a manufacturer regularly engaged in the manufacture of such products unless specified otherwise. Provide commercial grade components and products used in the system that comply with these Specifications.
 - 2. Each component of equipment identifies the manufacturer's name, model, and applicable serial number. The Owner's authorized representative retains the right to reject products that reflect, in their opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.
- M. Certifications
 - 1. Refer to individual Division sections for Submittal requirements.
- N. Sustainability Standards Certifications
 - 1. Refer to individual Division sections for Submittal requirements.
- O. Preconstruction Testing
 - 1. Refer to individual Division sections for Submittal requirements.
- P. Site Samples
 - 1. Refer to individual Division sections for Submittal requirements.
- Q. Mock-ups
 - 1. Refer to individual Division sections for Submittal requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Assume custody and responsibility for the items upon delivery and determining that the contents are complete and in satisfactory condition for installation.
- B. The Contractor is responsible for handling and control of equipment and liable for material loss due to delivery and storage problems.
- C. Materials and equipment delivered and placed in storage will be stored with protection from the weather, humidity, and temperature variation, dirt, and dust or other contaminants.
- D. Coordinate deliveries and submittals with the General Contractor/Owner to ensure a timely scheduled installation.
- E. Equipment and materials are to be delivered to the site no more than three weeks prior to the commencement of its installation. Coordinate with General Contractor/Owner for the location of storage materials.

1.11 SITE CONDITIONS

- A. Existing Conditions:
 - 1. Prior to bidding, verify and become familiar with existing conditions by visiting the site.
 - 2. Include related costs associated with site factors in the initial bid proposal.
- B. Coordinate exact requirements governed by actual job conditions. Check information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.
- C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City, and Utility Company.

1.12 WARRANTY

- A. Provide a written guarantee covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.
- B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.
- C. Arrange to have the equipment factory representative present for those tests where the manufacturer's warranty could be impacted by the absence of a factory representative.
- D. Correct warranty items promptly upon notification.
- E. Apparatus:
 - 1. Free of defects of material and workmanship and in accord with the Contract Documents.
 - 2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.

1.13 UNINTERRUPTED SERVICE

- A. Maintain electrical, signal and communication services to all functioning portions of the building throughout construction.
- B. Pre-arrange with Owner outages necessary for new construction.
 - 1. Comply with Division 01, General Requirements.
 - 2. Apply for scheduled shutdowns a minimum of 4 weeks prior to time needed and reconfirm a minimum of 72 hours prior to time needed.
 - 3. Contractor is liable for any damages resulting from unscheduled outages or for those not confined to the pre-arranged times. Damages include costs incurred by the Owner and by the Owner's tenants.

1.14 DEMOLITION AND SALVAGE

- A. General:
 - 1. Where affected by work, remove or relocate equipment, services, and systems encountered during the course of the remodel/construction work to a safe location that will be undisrupted by further construction.
 - 2. Disconnect electrical service to hard-wired equipment scheduled for removal under other Divisions of Work.
 - 3. Wiring which serves usable existing outlets restored and routed clear of the construction or demolition.
 - 4. Safely cut off and terminate wiring abandoned and removed to leave site clean.
- B. Reuse of Existing:
 - 1. Existing concealed conduits in good condition may be reused for installation of new wiring where available.
 - 2. Existing undamaged, properly supported surface conduits may be reused where surface conduits are called for, if the installation meets workmanship requirements of the Specifications.
 - 3. Where new wiring is added or existing wiring disturbed in existing branch circuit raceways, existing wires replaced with new.

- C. Salvage and Disposal:
 - 1. Removed materials, not containing hazardous waste, not scheduled for reuse are the property of the Contractor for removal from the site, except for those items specifically indicated on the Drawings for salvage or reuse.
 - 2. Identify materials containing, or possibly containing, hazardous waste for removal and disposal by the Hazardous Waste Contractor.
 - 3. Neatly store salvaged items at one location at the site where directed by the Owner's Representative.
 - 4. Salvage properly operating circuit breakers from panels scheduled for removal and use to replace faulty or inadequate breakers in existing panels scheduled to remain.

1.15 COMPLETION AND TESTING

- A. General:
 - 1. Comply with Division 01, General Requirements.
- B. Upon completion, test systems to show that installed equipment operates as designed and specified, free of faults and unintentional grounds.
 - 1. Schedule system tests so that several occur on the same day.
 - 2. Coordinate testing schedule with construction phasing.
 - 3. Conduct tests in the presence of the Architect or its representative.
 - 4. Notify Architect of tests 48 hours in advance.
- C. Engage a journeyman electrician with required tools to conduct equipment tests. Arrange to have the equipment factory representative present for those tests where the manufacturer's warranty could be impacted by the absence of a factory representative.
- D. Perform tests per the requirements of each of the following systems:
 - 1. Medium Voltage Distribution System
 - 2. Low Voltage Distribution System
 - 3. Emergency Power System
 - 4. Standby Power System
 - 5. Fire Alarm System
 - 6. Security System
 - 7. Public Address System
 - 8. Nurse Call System
 - 9. Lighting System
 - 10. Lighting Control System
 - 11. Power Metering and Monitoring System
 - 12. Power Factor Correction Capacitors
 - 13. UPS System
- E. Provide a written record of performance tests and submit with operation and maintenance data.

END OF SECTION 26 0500

**SECTION 26 0505
SELECTIVE DEMOLITION FOR ELECTRICAL**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

1.02 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical for submittal procedures.
- B. Sustainable Design Documentation: Submit certification of removal and appropriate disposal of abandoned cables containing lead stabilizers.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as indicated.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Architect before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify monitoring facility of prior to any system/wiring/device changes.
 - 3. Make notifications at least 24 hours in advance.
 - 4. Make temporary connections to maintain service in areas adjacent to work area.
- F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner at least 24 hours before partially or completely disabling system.
 - 2. Notify telephone service provider at least 24 hours before partially or completely disabling system.
 - 3. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
 - 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
 - 2. PCB- and DEHP-containing lighting ballasts.
 - 3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- I. Repair adjacent construction and finishes damaged during demolition and extension work.
- J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

- A. See Section 01 7419 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts/drivers and broken electrical parts.

END OF SECTION 26 0505

SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Wiring connectors.
- C. Oxide inhibiting compound.
- D. Wire pulling lubricant.
- E. Cable ties.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.
- E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers.
- F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation.
- G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- I. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable.
- J. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- K. NFPA 70 - National Electrical Code.
- L. UL 44 - Thermoset-Insulated Wires and Cables.
- M. UL 83 - Thermoplastic-Insulated Wires and Cables.
- N. UL 486A-486B - Wire Connectors.
- O. UL 486C - Splicing Wire Connectors.
- P. UL 486D - Sealed Wire Connector Systems.
- Q. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
- R. UL 854 - Service-Entrance Cables.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Metal-clad cable is not permitted.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
 - 1. Provide copper conductors except where aluminum conductors are specifically indicated. Substitution of aluminum conductors for copper is not permitted. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
 - 4. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.
- H. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.

- a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
- I. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- J. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - 3. Color Code:
 - a. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - b. Equipment Ground, All Systems: Green.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. General
 - b. Essex
 - c. Okonite
 - d. Cerro Wire LLC.
 - e. Encore Wire Corporation.
 - f. General Cable Technologies Corporation.
 - g. Southwire Company.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.

2.04 SERVICE ENTRANCE CABLE

- A. Manufacturers:
 - 1. Copper Service Entrance Cable:
 - a. Cerro Wire LLC.
 - b. Encore Wire Corporation.
 - c. Southwire Company.
 - d. Okonite
- B. Service Entrance Cable for Underground Use: NFPA 70, Type USE single-conductor cable listed and labeled as complying with UL 854, Type USE-2, and with UL 44 Type RHH/RHW-2.
- C. Conductor Stranding: Stranded.
- D. Insulation Voltage Rating: 600 V.

2.05 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 0526.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
 - 3. Connectors for Aluminum Conductors: Use compression connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 - 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 - 5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
 - 6. Aluminum Conductors: Use compression connectors for all connections.
 - 7. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
 - 8. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
 - 1. Manufacturers:
 - a. 3M.
 - b. Ideal Industries, Inc.
 - c. NSI Industries LLC.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
 - 1. Manufacturers:
 - a. Burndy LLC.
 - b. IlSCO.
 - c. Thomas & Betts Corporation.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
 - 1. Manufacturers:
 - a. Burndy LLC.
 - b. IlSCO.
 - c. Thomas & Betts Corporation.
- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
 - 1. Manufacturers:

- a. Burndy LLC.
- b. IlSCO.
- c. Thomas & Betts Corporation.

2.06 ACCESSORIES

- A. Electrical Tape:
 1. Manufacturers:
 - a. 3M.
 - b. Plymouth Rubber Europa.
 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
- B. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
 1. Manufacturers:
 - a. Burndy LLC.
 - b. Ideal Industries, Inc.
 - c. IlSCO.
- C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
 1. Manufacturers:
 - a. 3M.
 - b. American Polywater Corporation.
 - c. Ideal Industries, Inc.
- D. Cable Ties: Material and tensile strength rating suitable for application.
 1. Manufacturers:
 - a. Burndy LLC.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 2. When circuit destination is indicated without specific routing, determine exact routing required.
 3. Arrange circuiting to minimize splices.
 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.

5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
 - C. Perform work in accordance with NECA 1 (general workmanship).
 - D. Install aluminum conductors in accordance with NECA 104.
 - E. Installation in Raceway:
 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 2. Pull all conductors and cables together into raceway at same time.
 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
 - F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
 - G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
 - H. Install conductors with a minimum of 12 inches of slack at each outlet.
 - I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
 - J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
 - K. Make wiring connections using specified wiring connectors.
 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.
 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
 6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
 - L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

- M. Insulate ends of spare conductors using vinyl insulating electrical tape.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

END OF SECTION 26 0519

SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground access wells.

1.02 RELATED REQUIREMENTS

- A. Section 09 6500 - Resilient Flooring: Static control flooring.
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
 - 1. Includes oxide inhibiting compound.
- C. Section 26 0536 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 3100 - Photovoltaic Collectors: Additional grounding and bonding requirements for photovoltaic systems.
- F. Section 26 5600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
- D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- E. NFPA 70 - National Electrical Code.
- F. NFPA 99 - Health Care Facilities Code.
- G. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
- H. UL 467 - Grounding and Bonding Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. For signal reference grids, coordinate the work with access flooring furnished in accordance with Section 09 6900.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Shop Drawings:
 - 1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Field quality control test reports.
- F. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
 - 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- F. Grounding Electrode System:

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
5. Ground Ring:
 - a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
 - b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
 - c. Provide ground enhancement material around conductor where indicated.
 - d. Provide connection from ground ring conductor to:
 - 1) Perimeter columns of metal building frame.
 - 2) Ground rod electrodes located as indicated.
6. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 - d. Provide ground enhancement material around electrode where indicated.
 - e. Provide ground access well for each electrode.
7. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
8. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.

- b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- 9. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.
- G. Service-Supplied System Grounding:
 - 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 - 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
 - 1. Provide grounding electrode system for each separate building or structure.
 - 2. Provide equipment grounding conductor routed with supply conductors.
 - 3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
 - 4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.
- I. Separately Derived System Grounding:
 - 1. Separately derived systems include, but are not limited to:
 - a. Transformers (except autotransformers such as buck-boost transformers).
 - b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
 - c. Generators, when neutral is switched in the transfer switch.
 - 2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
 - 3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
 - 4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
 - 5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
 - 6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
 - 7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.
- J. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
 - c. Metal process piping.
 8. Provide bonding for interior metal air ducts.
 9. Provide bonding for metal building frame.
 10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
 11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.
 12. Provide redundant grounding and bonding for patient care areas of health care facilities in accordance with NFPA 70 and NFPA 99.
- K. Isolated Ground System:
1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
 2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
 3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.
- L. Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- M. Signal Reference Grids:

1. Provide signal reference grid on subfloor under access floors where indicated.
 2. Construct grid using field-welded sections of pre-fabricated signal reference grids.
 3. Unless otherwise indicated, locate grid between 6 and 18 inches (150 and 450 mm) from perimeter walls.
 4. Unless otherwise indicated, make bonding connections to signal reference grid using exothermic welded connections.
 5. Make bonding connections as short as possible, with no sharp folds or bends.
 6. Unless otherwise indicated, provide separate bonding connections from signal reference grid to each item to be bonded. Do not daisy chain items together to facilitate single point connection to signal reference grid.
 7. Provide 6 AWG bonding jumper to connect every sixth access floor pedestal in each direction to signal reference grid. Make connections to floor pedestals using exothermic welded connections.
 8. Provide 6 AWG bonding jumper to connect each steel column within and at the perimeter of room to signal reference grid. Make connections to steel columns using exothermic welded connections.
 9. Provide 6 AWG bonding jumper to connect each metal item such as conduits, pipes, ducts, etc. crossing the plane of, or within 6 feet (1.8 m) of, the signal reference grid. Make connections to conduits and pipes using listed ground clamps.
 10. Provide 6 AWG bonding jumper to connect signal reference grid to grounding point of separately derived systems serving equipment located on the signal reference grid.
 11. Provide low impedance risers to connect each equipment enclosure to signal reference grid. For each piece of equipment, provide two separate connections of different lengths connected to opposite sides of equipment and to different points on the signal reference grid. Make connections to equipment enclosures using mechanical connectors. Do not make connection to signal reference grid on the outermost grid conductor.
 12. Provide transient suppression plates on floor beneath items indicated. Provide 6 AWG bonding jumper to connect transient suppression plate to signal reference grid.
 - a. Transient Suppression Plates: Constructed from 26 gauge sheet copper, 4 by 4 feet unless otherwise indicated.
- N. Lightning Protection Systems:
1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
 2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.
- O. Cable Tray Systems: Also comply with Section 26 0536.
- P. Photovoltaic Systems: Also comply with Section 26 3100.
- Q. Pole-Mounted Luminaires: Also comply with Section 26 5600.
- R. Static Control Flooring: Provide bonding of static control flooring provided in accordance with Section 09 6500.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:

- 1) Use bare copper conductors where installed underground in direct contact with earth.
- 2) Use bare copper conductors where directly encased in concrete (not in raceway).
2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gauge of specified conductors.
- C. Connectors for Grounding and Bonding:
 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - a. Exceptions:
 - 1) Use mechanical connectors for connections to electrodes at ground access wells.
 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
 - a. Exceptions:
 - 1) Use exothermic welded connections for connections to metal building frame.
 4. Manufacturers - Mechanical and Compression Connectors:
 - a. Advanced Lightning Technology (ALT).
 - b. Burndy LLC.
 - c. Harger Lightning & Grounding.
 - d. Thomas & Betts Corporation.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
 5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy LLC.
 - b. Cadweld, a brand of Erico International Corporation.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- D. Ground Bars:
 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 2. Size: As indicated.
 3. Holes for Connections: As indicated or as required for connections to be made.
 4. Manufacturers:
 - a. Advanced Lightning Technology (ALT).
 - b. Erico International Corporation.
 - c. Harger Lightning & Grounding.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
- E. Ground Rod Electrodes:
 1. Comply with NEMA GR 1.
 2. Material: Copper-bonded (copper-clad) steel.
 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
 4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.
 5. Manufacturers:
 - a. Advanced Lightning Technology (ALT).
 - b. Erico International Corporation.
 - c. Galvan Industries, Inc.
 - d. Harger Lightning & Grounding.
 - e. _____.
 - f. Substitutions: See Section 01 6000 - Product Requirements.

- F. Ground Enhancement Material:
 - 1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.
 - 2. Resistivity: Not more than 20 ohm-cm in final installed form.
 - 3. Manufacturers:
 - a. Erico International Corporation.
 - b. Harger Lightning & Grounding.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- G. Ground Access Wells:
 - 1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
 - 2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
 - a. Round Wells: Not less than 8 inches in diameter.
 - b. Rectangular Wells: Not less than 12 by 12 inches.
 - 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
 - 4. Cover: Factory-identified by permanent means with word "GROUND".
 - 5. Manufacturers:
 - a. Advanced Lightning Technology (ALT).
 - b. Erico International Corporation.
 - c. Harger Lightning & Grounding.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
- H. Pre-Fabricated Signal Reference Grids:
 - 1. Description: Factory pre-fabricated grid manufactured from 2 inch wide, 26 gauge, flat copper strips spaced on 24 inch centers, factory-welded at each crossover.
 - 2. Low Impedance Risers: Factory fabricated 2 inch wide, 26 gauge, flat copper strips designed for connecting equipment enclosures to pre-fabricated signal reference grid.
 - 3. Manufacturers:
 - a. Advanced Lightning Technology (ALT).
 - b. Erico International Corporation.
 - c. Harger Lightning & Grounding.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
- I. Oxide Inhibiting Compound: Comply with Section 26 0519.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).

- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 - 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
 - 2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
- D. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 26 0553.
- F. Ufer Ground: Provide a concrete encased building grounding electrode where shown on the Drawings. Grounding electrode to consist of a minimum of 20 feet of #4 AWG copper conductor cast into the bottom 6 inches of an exterior concrete foundation or footing.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION 26 0526

**SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 05 5000 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- C. Section 26 0533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- D. Section 26 0536 - Cable Trays for Electrical Systems: Additional support and attachment requirements for cable tray.
- E. Section 26 0533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- F. Section 26 2513 - Low-Voltage Busways: Additional support and attachment requirements for busway.
- G. Section 26 5100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- H. Section 26 5600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. MFMA-4 - Metal Framing Standards Publication.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- F. NFPA 70 - National Electrical Code.
- G. UL 5B - Strut-Type Channel Raceways and Fittings.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- D. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.
- E. Installer's Qualification Statement: Include evidence of compliance with specified requirements.
- F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- D. Installer Qualifications for Field-Welding: As specified in Section 05 5000.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

- B. Materials for Metal Fabricated Supports: Comply with Section 05 5000.
- C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
 - 3. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation.
 - b. Erico International Corporation.
 - c. O-Z/Gedney, a brand of Emerson Electric Co.
 - d. Thomas & Betts Corporation.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
- D. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
 - 1. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation.
 - b. Erico International Corporation.
 - c. O-Z/Gedney, a brand of Emerson Electric Co.
 - d. Thomas & Betts Corporation.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
- E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Comply with MFMA-4.
 - 2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
 - 3. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 4. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 - 5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
 - 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation.
 - b. Thomas & Betts Corporation.
 - c. Unistrut, a brand of Atkore International Inc.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
 - e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Busway Supports: 1/2 inch diameter.
 - c. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
 - d. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
 - e. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
 - f. Outlet Boxes: 1/4 inch diameter.
 - g. Luminaires: 1/4 inch diameter.
- G. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
 - 1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.

2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
 4. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation.
 - b. Erico International Corporation.
 - c. PHP Systems/Design.
 - d. Unistrut, a brand of Atkore International Inc.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
- H. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 4. Hollow Masonry: Use toggle bolts.
 5. Hollow Stud Walls: Use toggle bolts.
 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 7. Sheet Metal: Use sheet metal screws.
 8. Wood: Use wood screws.
 9. Plastic and lead anchors are not permitted.
 10. Powder-actuated fasteners are not permitted.
 11. Hammer-driven anchors and fasteners are not permitted.
 12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
 - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
 13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
 14. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc.
 - b. ITW Red Head, a division of Illinois Tool Works, Inc.
 - c. Powers Fasteners, Inc.
 - d. Simpson Strong-Tie Company Inc.
 - e. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Field-Welding (where approved by Architect): Comply with Section 05 5000.
- I. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- J. Conduit Support and Attachment: Also comply with Section 26 0533.13.
- K. Cable Tray Support and Attachment: Also comply with Section 26 0536.
- L. Box Support and Attachment: Also comply with Section 26 0533.16.
- M. Busway Support and Attachment: Also comply with Section 26 2513.
- N. Interior Luminaire Support and Attachment: Also comply with Section 26 5100.
- O. Exterior Luminaire Support and Attachment: Also comply with Section 26 5600.
- P. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- Q. Secure fasteners according to manufacturer's recommended torque settings.
- R. Remove temporary supports.
- S. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 26 0529

SECTION 26 0533.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Aluminum rigid metal conduit (RMC).
- C. Intermediate metal conduit (IMC).
- D. PVC-coated galvanized steel rigid metal conduit (RMC).
- E. Flexible metal conduit (FMC).
- F. Liquidtight flexible metal conduit (LFMC).
- G. Electrical metallic tubing (EMT).
- H. Rigid polyvinyl chloride (PVC) conduit.
- I. Reinforced thermosetting resin conduit (RTRC).
- J. Conduit fittings.
- K. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 07 8400 - Firestopping.
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- D. Section 26 0529 - Hangers and Supports for Electrical Systems.
- E. Section 26 0548 - Vibration and Seismic Controls for Electrical Systems.
- F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 26 2100 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.
- H. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
- C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A).
- D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC).
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).
- G. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit.
- H. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- I. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.
- K. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- L. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series.
- M. NFPA 70 - National Electrical Code.
- N. UL 1 - Flexible Metal Conduit.
- O. UL 6 - Electrical Rigid Metal Conduit-Steel.
- P. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel.

- Q. UL 360 - Liquid-Tight Flexible Steel Conduit.
- R. UL 514B - Conduit, Tubing, and Cable Fittings.
- S. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- T. UL 797 - Electrical Metallic Tubing-Steel.
- U. UL 1242 - Electrical Intermediate Metal Conduit-Steel.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Shop Drawings:
 - 1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
 - 2. Include proposed locations of roof penetrations and proposed methods for sealing.
- D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
1. Under Slab on Grade: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
 2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
 3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
 5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
 6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use PVC-coated galvanized steel rigid metal conduit.
 7. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.
- D. Embedded Within Concrete:
1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
 2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
 3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.
 5. Where electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.
- E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.

1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical communications rooms or closets.
 - b. Where exposed below 20 feet in warehouse areas.
- K. Exposed, Exterior: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.
- L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- M. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit or MC cable whip.
 1. Maximum Length: 6 feet.
- N. Connections to Vibrating Equipment:
 1. Dry Locations: Use flexible metal conduit or liquidtight flexible metal conduit.
 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 3. Maximum Length: 6 feet unless otherwise indicated.
 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.
- O. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.02 CONDUIT REQUIREMENTS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Electrical Service Conduits: Also comply with Section 26 2100.
- C. Communications Systems Conduits: Also comply with this Section.
- D. Fittings for Grounding and Bonding: Also comply with Section 26 0526.
- E. Provide conduit, fittings, supports, and accessories required for a complete raceway system.
- F. Provide products listed, classified, and labeled as suitable for the purpose intended.
- G. Minimum Conduit Size, Unless Otherwise Indicated:
 1. Branch Circuits: 3/4 inch (21 mm) trade size.
 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
 3. Control Circuits: 3/4 inch (21 mm) trade size.
 4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.
 5. Underground, Interior: 3/4 inch (21 mm) trade size.
 6. Underground, Exterior: 3/4 inch (21 mm) trade size.
- H. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 1. Allied Tube & Conduit.
 2. Republic Conduit.
 3. Wheatland Tube Company.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings Inc.
 - b. O-Z/Gedney, a brand of Emerson Electric Co.
 - c. Thomas & Betts Corporation.

2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 ALUMINUM RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 1. Allied Tube & Conduit.
 2. Republic Conduit.
 3. Wheatland Tube Company.
- B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.
- C. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings Inc.
 - b. O-Z/Gedney, a brand of Emerson Electric Co.
 - c. Thomas & Betts Corporation.
 2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use aluminum.
 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 INTERMEDIATE METAL CONDUIT (IMC)

- A. Manufacturers:
 1. Allied Tube & Conduit.
 2. Republic Conduit.
 3. Wheatland Tube Company.
- B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- C. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings Inc.
 - b. O-Z/Gedney, a brand of Emerson Electric Co.
 - c. Thomas & Betts Corporation.
 2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.06 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 1. Thomas & Betts Corporation.
 2. Robroy Industries.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- D. PVC-Coated Fittings:

1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
- E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.07 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
1. AFC Cable Systems, Inc.
 2. Electri-Flex Company.
 3. International Metal Hose.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
1. Manufacturers:
 - a. Bridgeport Fittings Inc.
 - b. O-Z/Gedney, a brand of Emerson Electric Co.
 - c. Thomas & Betts Corporation.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.

2.08 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
1. AFC Cable Systems, Inc.
 2. Electri-Flex Company.
 3. International Metal Hose.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
1. Manufacturers:
 - a. Bridgeport Fittings Inc.
 - b. O-Z/Gedney, a brand of Emerson Electric Co.
 - c. Thomas & Betts Corporation.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.

2.09 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
1. Allied Tube & Conduit.
 2. Republic Conduit.
 3. Wheatland Tube Company.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
1. Manufacturers:
 - a. Bridgeport Fittings Inc.
 - b. O-Z/Gedney, a brand of Emerson Electric Co.
 - c. Thomas & Betts Corporation.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
4. Connectors and Couplings: Use compression (gland) or set-screw type.
 - a. Do not use indenter type connectors and couplings.
5. Use in dry protected locations for circuits rated 600V and less. Exceptions:
 - a. EMT is acceptable for outdoor use in photovoltaic roof applications.
 - b. EMT is acceptable for other outdoor applications in covered locations.
 - c. For outdoor applications, raintight fittings must be used.

2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 1. Cantex Inc.
 2. Carlon, a brand of Thomas & Betts Corporation.
 3. JM Eagle.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
 1. Manufacturer: Same as manufacturer of conduit to be connected.
 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.11 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

- A. Manufacturers:
 1. Champion Fiberglass, Inc.
 2. FRE Composites.
 3. United Fiberglass of America, Inc.
- B. Applications:
- C. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).
- D. Supports: Per manufacturer's recommendations.
- E. Fittings: Same type and manufacturer as conduit to be connected.

2.12 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- E. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.
- E. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- H. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 - 5. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
 - 9. Arrange conduit to provide no more than 150 feet between pull points.
 - 10. Route conduits above water and drain piping where possible.
 - 11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 - 13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 - 14. Group parallel conduits in the same area together on a common rack.
- I. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide required vibration isolation and/or seismic controls in accordance with Section 26 0548.
 - 3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 - 4. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.

5. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 6. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 7. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 8. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
 9. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
 10. Use of spring steel conduit clips for support of conduits is permitted only as follows:
 - a. Support of electrical metallic tubing (EMT) up to 1 inch (27 mm) trade size concealed above accessible ceilings and within hollow stud walls.
 11. Use of wire for support of conduits is permitted only as follows:
 - a. For securing conduits to studs in hollow stud walls.
 - b. For suspending conduits supported by spring steel conduit clips (only where specifically indicated or permitted).
 12. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.
- J. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
 7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- K. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.

7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
 8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- L. Underground Installation:
1. Provide trenching and backfilling in accordance with Section 31 2316.13.
 2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
 3. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length for service entrance where not concrete-encased.
- M. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Include proposed conduit arrangement with submittals.
 2. Maximum Conduit Size: 3/4 inch (21 mm) unless otherwise approved.
 3. Install conduits within middle one third of slab thickness.
 4. Secure conduits to prevent floating or movement during pouring of concrete.
- N. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 3000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.
- O. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
 4. Where conduits are subject to earth movement by settlement or frost.
- P. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- Q. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- R. Provide grounding and bonding in accordance with Section 26 0526.
- S. Identify conduits in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 0533.13

SECTION 26 0533.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Boxes for hazardous (classified) locations.
- E. Floor boxes.
- F. Underground boxes/enclosures.
- G. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 08 3100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0533.13 - Conduit for Electrical Systems:
 - 1. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 2726 - Wiring Devices:
 - 1. Wall plates.
 - 2. Floor box service fittings.
 - 3. Additional requirements for locating boxes for wiring devices.
- F. Section 27 1000 - Structured Cabling: Additional requirements for communications systems outlet boxes.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- F. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
- G. NFPA 70 - National Electrical Code.
- H. SCTE 77 - Specification for Underground Enclosure Integrity.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- K. UL 508A - Industrial Control Panels.
- L. UL 514A - Metallic Outlet Boxes.
- M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
- N. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
 1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.
- C. Samples:
 1. Floor Boxes: Provide one sample(s) of each floor box proposed for substitution upon request.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 6000 - Product Requirements, for additional provisions.
 2. Keys for Lockable Enclosures: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.

2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
 4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
 5. Use nonmetallic boxes where exposed rigid PVC conduit is used.
 6. Use suitable concrete type boxes where flush-mounted in concrete.
 7. Use suitable masonry type boxes where flush-mounted in masonry walls.
 8. Use raised covers suitable for the type of wall construction and device configuration where required.
 9. Use shallow boxes where required by the type of wall construction.
 10. Do not use "through-wall" boxes designed for access from both sides of wall.
 11. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 12. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 13. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
 14. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 15. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 16. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
 - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
 17. Wall Plates: Comply with Section 26 2726.
 18. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation.
 - b. Hubbell Incorporated; Bell Products.
 - c. Hubbell Incorporated; RACO Products.
 - d. O-Z/Gedney, a brand of Emerson Electric Co.
 - e. Thomas & Betts Corporation.
 - f. Substitutions: See Section 01 6000 - Product Requirements.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:

1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 - c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation.
 - b. Hoffman, a brand of Pentair Technical Products.
 - c. Hubbell Incorporated; Wiegmann Products.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.
1. Manufacturers:
 - a. Hubbell Incorporated.
 - b. Substitutions: See Section 01 6000 - Product Requirements.
- E. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
1. Manufacturers:
 - a. Appleton, a brand of Emerson Electric Co.
 - b. Cooper Crouse-Hinds, a division of Eaton Corporation.
 - c. Hubbell Incorporated; Killark Products.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- F. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 2726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
 2. Use cast iron floor boxes within slab on grade.
 3. Use sheet-steel or cast iron floor boxes within slab above grade.
 4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
 5. Manufacturer: Same as manufacturer of floor box service fittings.
- G. Underground Boxes/Enclosures:
1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
 2. Size: As indicated on drawings.
 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
 4. Provide logo on cover to indicate type of service.

5. Applications:
 - a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 8 load rating.
 - b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 15 load rating.
 - c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
 - a. Manufacturers:
 - 1) Hubbell Incorporated; Quazite Products.
 - 2) MacLean Highline.
 - 3) Oldcastle Precast, Inc.
 - 4) Substitutions: See Section 01 6000 - Product Requirements.
 - b. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.
 - c. Product(s):
 - 1) MacLean Highline PHA Series: Straight wall, all-polymer concrete splice box/pull box; available Tier 8, Tier 15, and Tier 22 load ratings.
 - (a) 11 by 18 by 12 inches nominal; Model PHA111812 (stackable).
 - 2) MacLean Highline CHA Series: Fiberglass/polymer concrete splice box/pull box; available Tier 8 and Tier 15 load ratings.
 - (a) 11 by 18 by 12 inches nominal; Model CHA111812.
 - 3) MacLean Highline CVA Series: Fiberglass/polymer concrete splice vault; available Tier 8, Tier 15, and Tier 22 load ratings.
 - (a) 30 by 48 by 18 inches nominal; Model CVA304818.

2.02 ACCESSORIES

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
 2. Unless dimensioned, box locations indicated are approximate.
 3. Locate boxes as required for devices installed under other sections or by others.
 - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 2726.
 - b. Communications Systems Outlets: Comply with Section 27 1000.

4. Locate boxes so that wall plates do not span different building finishes.
5. Locate boxes so that wall plates do not cross masonry joints.
6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.13.
11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- I. Box Supports:
 1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:
 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Floor-Mounted Cabinets: Mount on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
- M. Install boxes as required to preserve insulation integrity.
- N. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.
- O. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.

- P. Underground Boxes/Enclosures:
 - 1. Install enclosure on gravel base, minimum 6 inches deep.
 - 2. Flush-mount enclosures located in concrete or paved areas.
 - 3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.
 - 4. Provide cast-in-place concrete collar constructed in accordance with Section 03 3000, minimum 10 inches wide by 12 inches deep, around enclosures that are not located in concrete areas.
 - 5. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.
- Q. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- S. Close unused box openings.
- T. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- U. Provide grounding and bonding in accordance with Section 26 0526.
- V. Identify boxes in accordance with Section 26 0553.

3.03 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26 0533.16

SECTION 26 0543
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. The Sections includes:
 - 1. Precast Concrete Handholes and Boxes.
 - 2. Precast Concrete Manholes.
 - 3. Duct Lines.
 - 4. Spacers.
 - 5. Ground Rods.
 - 6. Ground Wire.
 - 7. Conduit Expansion/Deflection Fittings.

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 03, Concrete
- C. Division 26, Electrical
- D. Division 31, Earthwork

1.03 REFERENCED STANDARDS

- A. References listed below:
 - 1. American Association of State Highway and Transportation Officials
 - 2. American Concrete Institute
 - 3. American National Standards Institute
 - 4. American Society for Testing and Materials
 - 5. National Electrical Code
 - 6. National Electrical Manufacturers Association
 - 7. Underwriters Laboratories

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit descriptive details of the manufacturers' proposed standard product listings, including:
 - a. Precast manholes and handholes.
 - b. Precast manhole and handhole accessories, including covers and frames.
 - c. Precast concrete 28-day compressive strength data.
 - d. Manhole and handhole cement certification.
 - e. Duct bank cement certification.
 - f. Duct spacers.
 - g. Ducts and raceways.
 - h. Conduit expansion/deflection fittings.
- B. Show drawings for manholes and handholes, including:
 - 1. Design criteria signed by professional structural engineer licensed by the State of Oregon.
 - 2. Reinforcing steel locations and concrete covers.
 - 3. Layout of inserts, attachments, and openings.
 - 4. Locations and types of joints.
 - 5. Accessories, including covers, frames, and diamond plate doors where applicable.
- C. Duct-Bank Coordination Drawings: show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Sign and seal drawings by a qualified professional engineer licensed by the State of Oregon.

PART 2 PRODUCTS

2.01 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Handholes and Boxes:
 1. Precast concrete, 4,000 psi strength at 28 days, with reinforcing and galvanized checker plate traffic covers designed for AASHTO loading of H-20.
 2. Wall thickness 3-inches minimum.
- B. Precast Units:
 1. Conform to ASTM C 478.
 2. Size, plan area and clear height not less than shown on the drawings and have concrete slab bottoms with sumps.
- C. Pulling Irons: 7/8-inch diameter hot-dip galvanized steel bar with exposed triangular opening.
- D. Design:
 1. Precast structures shall be designed in accordance with AASHTO Specification for Highway Bridges. Concrete and reinforcing shall be designed in accordance with ACI 318.
 2. Tops and walls of structures designed for AASHTO H-20 highway loading, with 30 percent loading added for impact.
 3. Design walls to withstand soil pressures, taking into consideration the soil to be encountered and ground water level present at the site.
 4. Assume ground water level is at ground surface unless a lower water table is indicated in the boring logs. Design and construct precast handhole pull boxes not to float.
- E. Identify structures with manufacturer's name embedded in, or otherwise permanently attached to, an interior wall face.
- F. Covers for handholes and boxes spring-assisted galvanized diamond plate door with locking latch, 3-inch high markings in weld bead, inscribed before galvanizing with the word, ELECTRICAL, COMMUNICATION, or DATA. Identify the covers.
- G. Acceptable Manufacturers:
 1. Utility Vault Company
 2. Hanson
 3. Renton Concrete Products
 4. Or equal.

2.02 PRECAST CONCRETE MANHOLES

- A. Manholes:
 1. Precast concrete, minimum 4,000 psi strength at 28 days, with reinforcing and cover designed for AASHTO loading of H-20.
 2. Wall thickness 3-inches minimum. Necking and shaft shall have 36-inch minimum clear opening.
- B. Precast Units:
 1. Conform to ASTM C 478.
 2. Size, plan area and clear height not less than shown on the drawings with concrete slab bottoms with sumps.
- C. Pulling Irons: 7/8-inch diameter, hot-dip galvanized steel bar with exposed triangular opening.
- D. Design:
 1. Precast structures designed in accordance with AASHTO Specification for Highway Bridges. Concrete and reinforcing shall be designed in accordance with ACI 318.

2. Tops and walls of structures shall be designed for AASHTO H-20 highway loading, with 30 percent loading added for impact.
 3. Design walls to withstand soil pressures, taking into consideration the soil to be encountered and groundwater level present at the site.
 4. Assume ground water level is at ground surface unless a lower water table is indicated in the boring logs. Precast manholes shall be designed and constructed not to float.
- E. Identify structures with manufacturer's name embedded in, or otherwise permanently attached to, an interior wall face.
- F. Manhole Cover and Frame: Class 30B grey cast iron per ASTM A 48 with machine-finished, flat, bearing surfaces.
- G. Frame: Solid cast ductile iron with a 36-inch round opening. The cover shall have holes for lifting and shall have minimum 2-inch high factory label TELEPHONE, ELECTRIC, or ELECTRIC HV, as appropriate or as noted on the drawings.
- H. Manufacturers:
1. Utility Vault Company
 2. Hanson
 3. Renton Concrete Products
 4. Or equal.

2.03 DUCT LINES

- A. Size: Except where otherwise shown on the drawings, ducts and conduits shall not be less than 4-inch trade size.
- B. Ducts (Concrete-Encased):
1. Type II PVC Schedule 40, suitable for use with 194 degree F rated wire.
 2. Conduit conforms to UL Standard 651 and carry appropriate UL listing for below-ground use.
- C. Ducts (Direct-Buried):
1. Rigid Non-Metallic Conduit:
 - a. Type II PVC Schedule 40, suitable for use with 90 degrees C rated wire.
 - b. Conduit conforms to UL Standard 651 and carry appropriate UL listing for above- and below-ground use.
 2. Rigid Metal Conduit:
 - a. UL 6 galvanized rigid steel.
 - b. Where metal conduit is shown on the drawings or specified below, conduit has a coating of 20 mil bonded PVC, or coated with bituminous asphaltic compound.
- D. Ducts for Fiber Optic Trunk Lines (Non-Metallic):
1. PVC Schedule 40, UL listed for underground use with optical fiber or communications cables.
 2. Provide 4-inch by 1-inch nominal innerducts.
 3. Prelubricate innerducts to meet Bellcore GR356-CORE coefficient of friction requirements.
 4. Four-cell color scheme shall be white-orange-green-gray.
 5. Coupling: O-ring gasket to allow for easy joining yet provide resistance to pull out and to provide a watertight seal.
 6. Ducts available in 20-foot sections.
 7. Manufacturers:
 8. Carlon
 9. Or equal.
- E. Ducts for Fiber Optic Trunk Lines (Metallic):
1. Galvanized steel, with factory-installed reverse spin coupling for easy assembly without turning outer shell.

2. Provide 4-inch by 1-inch nominal innerducts.
 3. Prelubricate innerducts to meet Bellcore GR356-CORE coefficient of friction requirements.
 4. Four-Cell Color Scheme: White-orange-green-gray.
 5. Coupling: O-ring gasket to allow for easy joining yet provide resistance to pull out and to provide a watertight seal.
 6. Ducts available in 10-foot sections.
 7. Manufacturers:
 8. Carlon
 9. Or equal.
- F. Manufactured bends shall be not less than 36-inches in radius for conduits 4-inches in diameter or larger.

2.04 SPACERS

- A. Factory-fabricated rigid PVC vertical and horizontal interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum of 3-inches separation between ducts while supporting ducts during concreting or backfilling.
- B. Manufacturers:
 1. Carlon
 2. Orangeburg
 3. Or equal.

2.05 GROUND RODS

- A. Copper-clad steel, 3/4-inch diameter and 10-feet long.

2.06 GROUND WIRE

- A. Ground wire shall be stranded bare copper 6 AWG minimum.

2.07 CONDUIT EXPANSION/DEFLECTION FITTINGS

- A. Conduit expansion/deflection fittings in embedded runs rated for indoor use, outdoor use, buried underground, or embedded in concrete in non-hazardous areas.
- B. Allow axial expansion or contraction up to 3/4-inch and angular misalignment of the axes of the coupled runs in any direction to 30 degrees. Inner sleeves maintain constant inside diameter in any position and provide smooth insulated wireway for protection of wire insulation.
- C. Watertight flexible neoprene outer jacket and tinned copper flexible braid grounding strap.
- D. Use with galvanized rigid steel conduit or PVC Schedule 40 conduit utilizing rigid metal conduit nipples and rigid metal to PVC adapters.
- E. Manufacturers:
 1. Crouse-Hinds
 2. O-Z/Gedney
 3. Or equal.

PART 3 EXECUTION

3.01 CONDUIT ENCASEMENT OR EMBEDMENT (STRUCTURES AND DUCT BANKS)

- A. Concrete class 3500-3/4 with red dye.
- B. Concrete-embedded conduit shall be separated from the earth by at least 3-inches of concrete. Clearances shall be equal to the conduit diameter, but not less than 1-1/2-inches. Clearances shall also be maintained between conduits encased in slabs. Clearances of less than 1-1/2-inches at conduit crossing and terminating locations are acceptable.
- C. Provide conduit expansion/deflection fittings where embedded conduit crosses building expansion joints, passes between two adjacent structures, or passes between a duct bank and structure. Locate conduit expansion/deflection fittings between duct bank and manholes or pull boxes where noted on the drawings.

- D. Place duct banks on an undisturbed soil base wherever possible. Where duct banks pass through backfilled areas, the soil base shall be as specified elsewhere in the project manual. Duct banks that run under traffic areas shall be steel reinforced.
- E. Locate plastic spacers 5-feet to 8-feet on center as recommended by the manufacturer. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups. Secure spacers to earth and to ducts to prevent conduit flotation during concreting. Conduit runs shall be watertight.
- F. Protect conduit ends from damage during construction. When using plugs for protection, a 1/4-inch hole shall be drilled in the lower portion of the plug to provide drainage.
- G. Where a conduit is specified spare or for future use, install a nylon cord in conduit and fasten at each end.
- H. Pull leather-washer-type duct cleaner, with graduated washer sizes through full lengths of ducts immediately after concrete is poured. After the concrete has set but before backfilling, pull a 4-inch-long mandrel having a diameter equal to the conduits inside diameter minus 1/2-inch through each conduit. The mandrel shall be lead-covered or painted white so that it will indicate any protrusion on the inside of the conduit.

3.02 PRECAST MANHOLES AND HANDHOLE PULL BOXES

- A. Construction
 - 1. Units may be precast monolithically or may consist of assembled sections.
 - 2. Assembled sections shall have mating edges with tongue-and-groove joints. Joints shall be designed to firmly interlock adjoining components, and provide waterproof junctions. Joints shall be sealed watertight using preformed plastic strips installed in accordance with the manufacturer's instructions.
 - 3. Furnish lifting devices for proper handling of units.
 - 4. Provide ground rod and sleeve in manhole floors.
 - 5. Install sump with grate.
- B. Duct entries shall be a minimum of 14-inches above floor and below ceiling.
- C. Provide cable supports, clamps, or racks.
- D. Floor slope 2 percent in all directions to a sump.
- E. Sump a minimum of 8-inches in diameter.
- F. Install pulling irons or inserts for pulling eyes, inserts for cable racks, and openings for conduit entry as required. Steel components other than reinforced steel shall be hot-dip galvanized after fabrication. Manholes and handhole pull boxes shall have concrete bottoms.
- G. Install drains in electrical manholes and handhole pull boxes with a minimum 4-inch pipe set in the bottom and terminated in a minimum of 1 cubic yard of drain rock.
- H. Manholes and handhole pull boxes specifically noted on the drawings shall be drained into the storm water system. Seal vault watertight and drain coordinated with raceway entries.

3.03 INSTALLATION

- A. Install on a level bed of well-tamped gravel or crushed stone, well-graded from the 1-inch to 2-inch sieve.
 - 1. The top of frame and covers shall be flush with the finished surface of pavements, and flush with finished grade in unpaved areas.
 - 2. Set manholes and handholes plumb to limit the depth of standing water to a maximum of 2-inches. Unless otherwise specified, manhole covers shall be set at grade.
 - 3. Construct a sufficient number of precast concrete and mortar courses between top of manhole and manhole frame to reach the required level. Grout the manhole frame to the chimney.

- B. Locate underground duct lines and manholes and handholes at the approximate locations shown on the drawings with due consideration given to the location of other utilities, grades, and paving.
- C. Provide windows for duct bank terminations and fill with concrete or non-shrink grout after duct placement.
- D. Provide pulling irons opposite each duct and conduit entrance. Pulling irons shall be cast in the walls opposite all duct windows approximately 6-inches above the top of the window.
- E. Ground Rods and Grounding:
 - 1. Rods protrude approximately 4-inches above the manhole floor.
 - 2. In precast manholes, drive a ground rod into the earth through the floor sleeve. After the manhole is set in place, fill the sleeve with sealant to make a watertight seal.
- F. Ground Wires:
 - 1. Install ground wires around the inside perimeter of the manhole and anchor them to the walls.
 - 2. Connect the wires to the ground rods by exothermic welding or approved compression process to form solid metal joints.
 - 3. Bond the ground wires to the exposed non-current-carrying metal parts of racks, etc., in the manholes. Also bond the wires to duct bank bare equipment grounding conductors.

3.04 TRENCHING

- A. Excavate trenches in accordance with Division 31, Earthwork.
- B. Work with extreme care near existing utilities to avoid damaging them. Cut the trenches neatly and uniformly.
- C. For Concrete-Encased Ducts:
 - 1. After excavation of the trench, drive stakes in the bottom of the trench at 4-foot intervals to establish the grade and route of the duct bank.
 - 2. Pitch the trenches uniformly toward manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching the ducts towards buildings.
 - 3. The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that the concrete envelope can be poured without soil inclusions. Use forms where the soil is not self-supporting.
 - 4. After the concrete-encased duct has sufficiently cured, backfill the trench in accordance with Division 31, Earthwork.

3.05 DUCT LINE INSTALLATIONS

- A. General:
 - 1. Duct line in accordance with the NEC, as shown on the drawings, and as specified.
 - 2. Slope duct to drain toward manholes and away from building and equipment entrances. Pitch not less than 4-inches in 100-feet. Curved sections in duct lines consist of long sweep bends with a minimum radius of 5-feet in the horizontal and vertical directions unless noted otherwise. Use of manufactured bends is limited to building entrances and stub-ups to equipment.
 - 3. Underground conduit stub-ups to equipment inside buildings shall be galvanized rigid steel and shall extend at least 10-feet outside the building foundation. Stub-ups to equipment, mounted on outdoor concrete slabs, shall be galvanized rigid steel and shall extend at least 5-feet from edge of slab. Install insulated grounding bushings on the terminations. Couple the steel conduits to the ducts with suitable adapters, and encase with 3-inches of concrete.

4. Upon completion of the duct bank installation, pull a standard flexible mandrel through each duct. The mandrel shall be at least 12-inches long, and shall have a diameter 1/2-inch less than the inside diameter of the duct. After mandrelling, pull a brush with stiff bristles through each duct to remove the loosened particles. Diameter of the brush equal to or slightly larger than the diameter of the duct.
 5. Seal the ducts and conduits at building entrances and at outdoor equipment terminations with a suitable non-hardening compound.
- B. Fiber Optic Trunk Conduits:
1. Conduits: Join, terminate, and seal with fittings, materials and methods recommended by the manufacturer. Supply necessary fittings and materials for a complete fiber optic conduit/duct system.
 2. Submit a complete material list for approval prior to purchasing materials and indicate locations of material usage.
- C. Concrete-Encased Ducts:
1. Duct lines shall consist of single or multiple duct assemblies encased in concrete, and installed with top of duct bank not less than 36-inches below established grade unless otherwise indicated. Ducts shall be uniform in size and material throughout the installation.
 2. Rigid base and intermediate spacers shall securely support and maintain uniform spacing of the duct assembly at least 3-inches above the trench bottom during pouring of concrete. Spacer spacing not to exceed 8-feet. Use a minimum of 3 spacers for each 20-foot length of duct.
 3. Clearances between individual ducts:
 - a. For like service, clearance not less than 3-inches.
 - b. For high voltage power and telephone services, clearance not less than 6-inches.
 - c. For high voltage and 600V services, clearance not less than 3-inches.
 - d. Provide tie wires to prevent displacement of the ducts during pouring of concrete. Tie wires not to act as substitutes for spacers.
 4. Terminate duct lines at window openings in manhole walls as shown on the drawings. Adjust window openings to correspond with duct line inverts. Fit ducts with end bells.
 5. Couple the ducts in staggered rows and layers to ensure maximum strength and rigidity of the duct bank.
 6. Extend the concrete envelope encasing the ducts at least 3-inches beyond the outside walls of the outer ducts and conduits.
 7. Install reinforcing steel bars within the top and bottom of each concrete envelope within 5-feet of the building, at manhole wall penetrations, under roadways, and between concrete pours. Where shown on the drawings, incorporate additional steel reinforcing in the duct envelopes.
 8. Keep ducts clean of earth, sand, or gravel during construction, and seal with tapered plugs upon completion of each portion of the work.
 9. Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, make the joints with the proper fittings and fabricate the concrete envelopes to ensure smooth, durable transitions.
 10. Place a continuous strip of utility warning tape approximately 12-inches above ducts before backfilling trenches. Refer to Division 31, Earthwork, for tape description and installation requirements.
- D. Direct Burial Duct and Conduits:
1. Install direct burial ducts and conduits only where shown on the drawings.
 2. Join and terminate ducts and conduits with fittings recommended by the conduit manufacturer.
 3. Tops of ducts and conduits not less than 24-inches below grade.

4. Do not kink the ducts or conduits.
5. Place a continuous strip of utility warning tape approximately 12-inches above ducts or conduits before backfilling trenches. Refer to Division 31, Earthwork, for tape description and installation requirements.

END OF SECTION 26 0543

SECTION 26 0548
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Seismic control requirements.
- C. Vibration-isolated equipment support bases.
- D. Vibration isolators.
- E. External seismic snubber assemblies.
- F. Seismic restraint systems.

1.02 RELATED REQUIREMENTS

- A. Section 01 4533 - Code-Required Special Inspections and Procedures.
- B. Section 03 3000 - Cast-in-Place Concrete.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.

1.03 DEFINITIONS

- A. Electrical Component: Where referenced in this section in regards to seismic controls, applies to any portion of the electrical system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., conduit, cable tray).
- B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.04 REFERENCE STANDARDS

- A. ASCE 19 - Structural Applications of Steel Cables for Buildings.
- B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications.
- C. FEMA 413 - Installing Seismic Restraints for Electrical Equipment.
- D. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- F. NFPA 70 - National Electrical Code.
- G. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems.

1.05 GENERAL REQUIREMENTS:

- A. Provide seismic restraints for equipment, both supported and suspended, conduits, and cable tray systems.
- B. Bracing of conduits and cable trays in accordance with the provisions set forth in the SMACNA seismic restraint manual and the requirements set in ASCE 7-10 Section 13.2.
- C. Review and approve structural requirements for restraints, including their attachment to the building structure by a registered structural engineer in the same state as the project.
- D. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.
- E. Seismic restraints, including anchors to building structure, designed by a registered professional structural engineer licensed in the state of Oregon. Design includes:
 - 1. Number, size, capacity, and location of anchors for floor- or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both the unit to the curb and the curb to the structure. For units weighing greater than 2500 pounds, or curbs more than 10 feet long, provide substantiating calculations the curb can accept the prescribed seismic forces.

2. Number, size, capacity, and location of seismic restraint devices and anchors for vibration-isolation and suspended equipment. Provide calculations, test data, or California OSHPD approval number verifying the horizontal and vertical ratings of the seismic restraint devices.
3. Number, size, capacity, and location of braces and anchors for suspended raceways, bus ducts, and cable trays on as-built plan drawings.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.
 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 4. Seismic Controls:
 - a. Coordinate the arrangement of seismic restraints with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - b. Coordinate the work with other trades to accommodate relative positioning of essential and nonessential components in consideration of seismic interaction.
 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.07 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
 2. Seismic Controls: Include seismic load capacities.
- D. Shop Drawings - Vibration Isolation Systems:
 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.
 2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.
- E. Shop Drawings - Seismic Controls:
 1. Include dimensioned plan views and sections indicating proposed electrical component locations and distributed system routing, with locations and details of gravity supports and seismic restraints and associated attachments.
 2. Identify anchor manufacturer, type, minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 3. Indicate proposed arrangement of distributed system trapeze support groupings.
 4. Indicate proposed locations for distributed system flexible fittings and/or connections.
 5. Indicate locations of seismic separations where applicable.

1.08 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Supports, Hangers, and Anchors: Comply with the requirements of Section 26 0529 - Hangers and Supports for Electrical Systems meet the requirements of ASCE 7-10 Section 13.2 based on the Seismic Design Criteria located on the structural drawings.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

- A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing electrical equipment and/or electrical connections to vibration-isolated equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
 - 3. Select seismic type vibration isolators to comply with seismic design requirements, including conditions of equipment seismic certification where applicable.
 - 4. Select vibration isolators for outdoor equipment to comply with wind design requirements.
 - 5. Select vibration-isolated equipment support bases and associated vibration isolators to provide minimum 2-inch operating clearance beneath base unless otherwise indicated.
- D. Equipment Isolation:
 - 1. Transformers:
 - a. Specified vibration isolators are in addition to any factory-installed internal core and coil assembly vibration isolators unless otherwise indicated.
 - b. Floor-Mounted Transformers, Seismic Applications: Use seismic type resilient material isolator mounts or seismic type restrained spring isolators.
 - 2. Engine Generators:
 - a. Specified vibration isolators are in addition to any factory-installed internal vibration isolators between generator set and integral base unless otherwise indicated; obtain generator set manufacturer approval of applied vibration isolation.
- E. Conduit Isolation:
 - 1. Use flexible conduit or cable for electrical connections to vibration-isolated equipment, including equipment installed under other sections or by others.

2.02 SEISMIC CONTROL REQUIREMENTS

- A. Design and provide electrical component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor electrical components.
- B. Seismic Restraints:
 - 1. Provide seismic restraints for electrical components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.

2. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:
 - a. ASHRAE (HVACA).
 - b. FEMA 413.
 - c. FEMA E-74.
 - d. SMACNA (SRM).
 3. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.
 4. External Seismic Snubber Assemblies:
 - a. Provide quantity and arrangement of external seismic snubber assemblies as required to restrain equipment in all directions (both lateral and vertical).
 - b. Do not use external seismic snubber assemblies that restrain equipment only in one or more lateral directions (but not vertical) except where uplift forces are zero or are addressed by other restraints.
 5. Seismic Restraint Systems:
 - a. Except where otherwise restricted, use of either cable or rigid restraints is permitted.
 - b. Use only cable restraints to restrain vibration-isolated electrical components, including distributed systems.
 - c. Use only one restraint system type for a given electrical component or distributed system (e.g., conduit, cable tray) run; mixing of cable and rigid restraints on a given component/run is not permitted.
 - d. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain electrical component in all lateral directions; consider bracket geometry in anchor load calculations.
 - e. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid restraints loaded in tension, in excess of downward tensile load due to supported electrical component weight.
 - f. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported electrical component weight.
 - g. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.
 - h. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.
 - i. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.
- C. Seismic Attachments:
1. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.
 2. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) or qualified evaluation service acceptable to authorities having jurisdiction for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.
 3. Do not use power-actuated fasteners.

4. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps.
 5. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 6. Concrete Housekeeping Pads:
 - a. Increase size of pad as required to comply with anchor requirements.
 - b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.
- D. Seismic Interactions:
1. Include provisions to prevent seismic impact between electrical components and other structural or nonstructural components.
 2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.
- E. Seismic Relative Displacement Provisions:
1. Use suitable fittings or flexible connections to accommodate:
 - a. Relative displacements at connections between components, including distributed systems (e.g., conduit, cable tray); do not exceed load limits for equipment utility connections.
 - b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.
 - c. Design displacements at seismic separations.
 - d. Anticipated drifts between floors.

2.03 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

2.04 VIBRATION ISOLATORS

- A. General Requirements:
1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.

2.05 EXTERNAL SEISMIC SNUBBER ASSEMBLIES

- A. Description: Steel snubbing assemblies designed for external attachment to both equipment and supporting structure that, as part of a complete system, restrain equipment motion in all directions during a seismic event while maintaining vibration isolation during normal operation.
- B. Seismic Snubbing Elements:
1. Air Gap: Between 0.125 inches and 0.25 inches unless otherwise indicated.
 2. Points of Contact: Cushioned with resilient material, minimum 0.25 inch thick; capable of being visually inspected for damage and replaced.

2.06 SEISMIC RESTRAINT SYSTEMS

- A. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.
- B. Cable Restraints:
1. Comply with ASCE 19.
 2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.
 3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.
 4. Use protective thimbles for cable loops where potential for cable damage exists.
- C. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 CODE-REQUIRED SPECIAL INSPECTIONS

- A. Arrange work to accommodate tests and/or inspections performed by Special Inspection Agency employed by Owner or Architect in accordance with Section 01 4533 and statement of special inspections as required by applicable building code.
- B. Frequency of Special Inspections: Where special inspections are designated as continuous or periodic, arrange work accordingly.
 - 1. Continuous Special Inspections: Special Inspection Agency to be present in the area where the work is being performed and observe the work at all times the work is in progress.
 - 2. Periodic Special Inspections: Special Inspection Agency to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.
- C. Prior to starting work, Contractor to submit written statement of responsibility to authorities having jurisdiction and to Owner acknowledging awareness of special requirements contained in the statement of special inspections.
- D. Special Inspection Agency services do not relieve Contractor from performing inspections and testing specified elsewhere.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install products in accordance with applicable requirements of NECA 1 (general workmanship).
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Secure fasteners according to manufacturer's recommended torque settings.
- E. Install flexible conduit and cable connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- F. Vibration Isolation Systems:
 - 1. Vibration-Isolated Equipment Support Bases:
 - a. Provide specified minimum clearance beneath base.
 - 2. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
 - 3. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
 - 4. Adjust isolators to be free of isolation short circuits during normal operation.
 - 5. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.
- G. Seismic Controls:
 - 1. Provide specified snubbing element air gap; remove any factory-installed spacers, debris or other obstructions.
 - 2. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.
 - 3. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch, use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch or less.

4. Equipment with Sheet Metal Housings:
 - a. Use Belleville washers to distribute stress over a larger surface area of the sheet metal connection interface as approved by manufacturer.
 - b. Attach additional steel as approved by manufacturer where required to transfer loads to structure.
 - c. Where mounting surface is irregular, do not shim housing; reinforce housing with additional steel as approved by manufacturer.
5. Concrete Housekeeping Pads:
 - a. Size in accordance with seismic design to meet anchor requirements.
 - b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.
6. Seismic Restraint Systems:
 - a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.
 - b. Install restraints within permissible angles in accordance with seismic design.
 - c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.
 - d. Install cable restraints for vibration-isolated components slightly slack to prevent short-circuiting of isolation.
 - e. Install hanger rod stiffeners where indicated using only specified clamps; do not weld stiffeners to hanger rod.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect vibration isolation and/or seismic control components for damage and defects.
- C. Vibration Isolation Systems:
 1. Verify isolator static deflections.
 2. Verify required clearance beneath vibration-isolated equipment support bases.
 3. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.
- D. Seismic Controls:
 1. Verify snubbing element air gaps.
- E. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION 26 0548

**SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Floor marking tape.
- G. Warning signs and labels.

1.02 RELATED REQUIREMENTS

- A. Section 09 9113 - Exterior Painting.
- B. Section 09 9123 - Interior Painting.
- C. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 26 0536 - Cable Trays for Electrical Systems: Additional identification requirements for cable tray systems.
- E. Section 26 2300 - Low-Voltage Switchgear: Factory-installed mimic bus.
- F. Section 26 2726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- G. Section 26 3100 - Photovoltaic Collectors: Additional identification requirements for photovoltaic systems.
- H. Section 27 1000 - Structured Cabling: Identification for communications cabling and devices.

1.03 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- C. NFPA 70 - National Electrical Code.
- D. NFPA 70E - Standard for Electrical Safety in the Workplace.
- E. UL 969 - Marking and Labeling Systems.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.
- D. Samples:
 - 1. Identification Nameplates: One of each type and color specified.

2. Warning Signs and Labels: One of each type and legend specified.
- E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.07 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchgear:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify main and tie devices.
 - 5) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
 - 6) See Section 26 2300 for factory-installed mimic bus.
 - b. Switchboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify main overcurrent protective device.
 - 5) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
 - c. Motor Control Centers:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify main overcurrent protective device.
 - 5) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
 - d. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.

- 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
- e. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify load(s) served. Include location when not within sight of equipment.
 - f. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - g. Busway:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Provide identification at maximum intervals of 40 feet.
 - 5) Use identification nameplate to identify load(s) served for each plug-in unit. Include location when not within sight of equipment.
 - h. Time Switches:
 - 1) Identify load(s) served and associated circuits controlled. Include location.
 - i. Enclosed Contactors:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
 - 4) Identify coil voltage.
 - 5) Identify load(s) and associated circuits controlled. Include location.
 - j. Transfer Switches:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - 4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
 - k. Electricity Meters:
 - 1) Identify load(s) metered.
2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.

- b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
3. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
 - c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
 4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
 5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
 6. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.
 7. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
 8. Use identification label on inside of door at each fused switch to identify required NEMA fuse class and size.
 9. Use identification label on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
 10. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
 11. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
 - a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 9123 and 09 9113.
 12. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.
 13. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Minimum Size: 3.5 by 5 inches.
 - b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.

- c. Service Equipment: Include the following information in accordance with NFPA 70.
 - 1) Nominal system voltage.
 - 2) Available fault current.
 - 3) Clearing time of service overcurrent protective device(s).
 - 4) Date label applied.
- 14. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
- 15. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
- 16. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
- 17. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.
- C. Identification for Conductors and Cables:
 - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
 - 2. Identification for Communications Conductors and Cables: Comply with Section 27 1000.
 - 3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
 - 4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
 - d. In cable tray, at maximum intervals of 20 feet.
 - 5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
 - 6. Use underground warning tape to identify direct buried cables.
- D. Identification for Raceways:
 - 1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
 - 2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
 - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Color Code:
 - (a) Emergency Power System: Red.
 - (b) Fire Alarm System: Red.
 - 2) Field-Painting: Comply with Section 09 9123 and 09 9113.
 - 3) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.

3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
 4. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
 5. Use underground warning tape to identify underground raceways.
 6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.
- E. Identification for Cable Tray: Comply with Section 26 0536.
- F. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
 2. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 09 9123 and 09 9113 per the same color code used for raceways.
 - b. For exposed boxes in public areas, do not color code.
 3. Use handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, provide identification on inside face of cover.
 4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
- G. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 27 1000.
 2. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.
 3. Factory Pre-Marked Wallplates: Comply with Section 26 2726.
 4. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
 5. Use identification label to identify serving branch circuit for all receptacles.
 - a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
 6. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
 7. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.
- H. Identification for Luminaires:
1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.
- I. Identification for Photovoltaic Systems: Comply with Section 26 3100

2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
1. Manufacturers:
 - a. Brady.
 - b. 3M.
 - c. Brimar Industries, Inc.
 - d. Kolbi Pipe Marker Co.
 - e. Seton Identification Products.
 - f. Substitutions: See Section 01 6000 - Product Requirements.

2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
1. Manufacturers:
 - a. 3M.
 - b. Brady Corporation.
 - c. Brother International Corporation.
 - d. Panduit Corp.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend:
 - a. System designation where applicable:
 - 1) Emergency Power System: Identify with text "EMERGENCY".
 - 2) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
 - c. Other information as indicated.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - c. Other Information: 1/4 inch.
 - d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
 - c. Fire Alarm System: White text on red background.
- D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 1/4 inch.
5. Color: Black text on white background unless otherwise indicated.
 - a. Exceptions:
 - 1) Provide white text on red background for general information or operational instructions for emergency systems.
 - 2) Provide white text on red background for general information or operational instructions for fire alarm systems.
- E. Format for Caution and Warning Messages:
 1. Minimum Size: 2 inches by 4 inches.
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 1/2 inch.
 5. Color: Black text on yellow background unless otherwise indicated.
- F. Format for Receptacle Identification:
 1. Minimum Size: 3/8 inch by 1.5 inches.
 2. Legend: Power source and circuit number or other designation indicated.
 - a. Include voltage and phase for other than 120 V, single phase circuits.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch.
 5. Color: Black text on clear background.
- G. Format for Control Device Identification:
 1. Minimum Size: 3/8 inch by 1.5 inches.
 2. Legend: Load controlled or other designation indicated.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch.
 5. Color: Black text on clear background.
- H. Format for Fire Alarm Device Identification:
 1. Minimum Size: 3/8 inch by 1.5 inches.
 2. Legend: Designation indicated and device zone or address.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch.
 5. Color: Red text on white background.

2.03 WIRE AND CABLE MARKERS

- A. Manufacturers:
 1. 3M.
 2. Brady Corporation.
 3. HellermannTyton.
 4. Panduit Corp.
 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
 1. Do not use handwritten text.
- F. Minimum Text Height: 1/8 inch.

G. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

- A. Manufacturers:
 - 1. 3M.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Seton Identification Products.
 - 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Minimum Size:
 - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 - 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 - 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- C. Legend:
 - 1. Markers for Voltage Identification: Highest voltage present.
 - 2. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
 - b. Other Systems: Type of service.
- D. Color: Black text on orange background unless otherwise indicated.

2.05 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Seton Identification Products.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
 - 1. Exception: Use foil-backed detectable type tape where required by serving utility or where directed by Owner.
- C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
- D. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
- E. Legend: Type of service, continuously repeated over full length of tape.
- F. Color:
 - 1. Tape for Buried Power Lines: Black text on red background.
 - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.06 FLOOR MARKING TAPE

- A. Manufacturers:
 - 1. 3M.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Seton Identification Products.
 - 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlamine, 3 inches wide, with alternating black and white stripes.

2.07 WARNING SIGNS AND LABELS

- A. Manufacturers:

1. Brimar Industries, Inc.
 2. Clarion Safety Systems, LLC.
 3. Seton Identification Products.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- D. Warning Labels:
1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Branch Devices: Adjacent to device.
 6. Interior Components: Legible from the point of access.
 7. Conduits: Legible from the floor.
 8. Boxes: Outside face of cover.
 9. Conductors and Cables: Legible from the point of access.
 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
 1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.
- H. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 26 0553

**SECTION 26 0573
POWER SYSTEM STUDIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Short-circuit study.
- B. Protective device coordination study.
- C. Arc flash and shock risk assessment.
 - 1. Includes arc flash hazard warning labels.
- D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.02 RELATED REQUIREMENTS

- A. Section 26 0553 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.

1.03 REFERENCE STANDARDS

- A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- B. IEEE 141 - IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants.
- C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
- D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis.
- E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems.
- F. IEEE 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations.
- G. NEMA MG 1 - Motors and Generators.
- H. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- I. NFPA 70 - National Electrical Code.
- J. NFPA 70E - Standard for Electrical Safety in the Workplace.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
 - 2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Pre-Study Meeting: Conduct meeting with Owner to discuss system operating modes and conditions to be considered in studies.
- C. Sequencing:
 - 1. Submit study reports prior to or concurrent with product submittals.
 - 2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.
 - 3. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable).
- D. Scheduling:
 - 1. Arrange access to existing facility for data collection with Owner.

2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Study preparer's qualifications.
- C. Field testing agency's qualifications.
- D. Study reports, stamped or sealed and signed by study preparer.
- E. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
 1. Include characteristic time-current trip curves for protective devices.
 2. Include impedance data for busway.
 3. Include impedance data for engine generators.
 4. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 5. Include documentation of listed series ratings upon request.
 6. Identify modifications made in accordance with studies that:
 - a. Can be made at no additional cost to Owner.
 - b. As submitted will involve a change to the contract sum.
- F. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.
- G. Site-specific arc flash hazard warning labels.
- H. Field quality control reports.
- I. Certification that field adjustable protective devices have been set in accordance with requirements of studies.
- J. Project Record Documents: Revise studies as required to reflect as-built conditions.
 1. Include hard copies with operation and maintenance data submittals.
 2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.06 POWER SYSTEM STUDIES

- A. Scope of Studies:
 1. Perform analysis of both new and directly affected existing portions of electrical distribution systems as indicated on drawings.
 2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
 3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
 - a. Known Operating Modes:
 - 1) Utility as source.
 - 2) Generator as source.
 - 3) Utility/generator in parallel.
 - 4) Bus tie breaker open/close positions.
 - 5) Maintenance settings.
- B. General Study Requirements:
 1. Comply with NFPA 70.
 2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.
- C. Data Collection:

1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
 - a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
 - 1) Obtain up-to-date information from Utility Company.
 - b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
 - c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
 - d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
 - e. Protective Devices:
 - 1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
 - 2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
 - f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
 - g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.
 2. Existing Installations:
 - a. Provide the services of field testing agency or equipment manufacturer's representative to perform field data collection.
 - b. Collect data on existing electrical distribution system necessary for completion of studies, including field verification of available existing data (e.g. construction documents, previous studies). Include actual settings for field-adjustable devices.
- D. Short-Circuit Study:
1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
 2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
 - a. Maximum utility fault currents.
 - b. Maximum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
 3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.
- E. Protective Device Coordination Study:
1. Comply with applicable portions of IEEE 242 and IEEE 399.
 2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
 3. Analyze protective devices and associated settings for suitable margins between time-current curves to provide adequate protection for equipment and conductors while achieving full selective coordination.
- F. Arc Flash and Shock Risk Assessment:
1. Comply with NFPA 70E.

2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
 - a. Where reasonable, study preparer may assume a maximum clearing time of two seconds in accordance with IEEE 1584, provided that the conditions are such that a worker's egress from an arc flash event would not be inhibited.
 - b. For single-phase systems, study preparer to perform calculations assuming three-phase system in accordance with IEEE 1584 using single phase bolted fault current, yielding conservative results.
 3. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.
 4. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
 - a. Maximum and minimum utility fault currents.
 - b. Maximum and minimum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
- G. Study Reports:
1. General Requirements:
 - a. Identify date of study and study preparer.
 - b. Identify study methodology and software product(s) used.
 - c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
 - d. Identify base used for per unit values.
 - e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
 - f. Include conclusions and recommendations.
 2. Short-Circuit Study:
 - a. For each scenario, identify at each bus location:
 - 1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
 - 2) Fault point X/R ratio.
 - 3) Associated equipment short circuit current ratings.
 - b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
 3. Protective Device Coordination Study:
 - a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
 - b. For each graph include (where applicable):
 - 1) Partial single-line diagram identifying the portion of the system illustrated.
 - 2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
 - 3) Conductors: Damage curves.
 - 4) Transformers: Inrush points and damage curves.
 - 5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
 - 6) Motors: Full load current, starting curves, and damage curves.
 - 7) Capacitors: Full load current and damage curves.
 - c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.

- 1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
 - 2) Include ground fault pickup and delay.
 - 3) Include fuse ratings.
 - 4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
- d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.
4. Arc Flash and Shock Risk Assessment:
- a. For the worst case for each scenario, identify at each bus location:
 - 1) Calculated incident energy and associated working distance.
 - 2) Calculated arc flash boundary.
 - 3) Bolted fault current.
 - 4) Arcing fault current.
 - 5) Clearing time.
 - 6) Arc gap distance.
 - b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.
 - c. Include recommendations for reducing the incident energy at locations where the calculated maximum incident energy exceeds 8 calories per sq cm.

1.07 QUALITY ASSURANCE

- A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in preparation of studies of similar type and complexity using specified computer software.
 1. Study preparer may be employed by manufacturer of electrical distribution equipment.
 2. Study preparer may be employed by field testing agency.
- B. Field Testing Agency Qualifications: Independent testing organization specializing in testing, analysis, and maintenance of electrical systems with minimum five years experience; NETA Accredited Company.
 1. Field Supervisor: Certified electrical testing technician; NETA ETT Level III.
- C. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
 1. Products:
 - a. EasyPower LLC.
 - b. ETAP/Operation Technology, Inc.
 - c. Power Analytics Corporation.
 - d. SKM Systems Analysis, Inc.
 - e. Substitutions: See Section 01 6000 - Product Requirements.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Emerson
- B. Electrical Systems Analysis
- C. Qualified engineers of the switchgear manufacturer

2.02 ARC FLASH HAZARD WARNING LABELS

- A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
 1. Materials: Comply with Section 26 0553.

2. Minimum Size: 4 by 6 inches.
3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
 - a. Include orange header that reads "WARNING" unless otherwise indicated.
 - b. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
 - c. Include the following information:
 - 1) Arc flash boundary.
 - 2) Available incident energy and corresponding working distance.
 - 3) Site-specific PPE (personnel protective equipment) requirements.
 - 4) Nominal system voltage.
 - 5) Limited approach boundary.
 - 6) Restricted approach boundary.
 - 7) Equipment identification.
 - 8) Study preparer, report reference, and date calculations were performed.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install arc flash warning labels in accordance with Section 26 0553.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide the services of field testing agency or equipment manufacturer's representative to perform inspection, testing, and adjusting.
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Adjust equipment and protective devices for compliance with studies and recommended settings.
- E. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.
- F. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

3.03 ARC FLASH TRAINING

- A. Train the Owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Training certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.

3.04 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Training: Include as part of the base bid training for Owner's personnel on electrical safety pertaining to arc flash and shock hazards.
 1. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.
 2. Provide minimum of eight hours of training.
 3. Instructor: Representative of entity performing study.
 4. Location: At project site.

3.05 ATTACHMENTS

- A. Previous studies.
- B. Existing drawings.

END OF SECTION 26 0573

**SECTION 26 0580
ELECTRICAL TESTING**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Testing Equipment

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 26, Electrical
- C. Section 26 0513 - Medium-Voltage Cables
- D. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables
- E. Section 26 0526 - Grounding and Bonding for Electrical Systems
- F. Section 26 0943 - Network Lighting Controls
- G. Section 26 1300 - Medium-Voltage Switchgear
- H. Section 26 1321 - Air Interrupter Switches
- I. Section 26 2413 - Switchboards
- J. Section 26 2713 - Electricity Metering
- K. Section 26 2416 - Panelboards
- L. Section 26 2913 - Enclosed Controllers
- M. Section 26 3213 - Engine Generators
- N. Section 26 3323 - Central Battery Equipment
- O. Section 26 3353 - Static Uninterruptible Power Supply
- P. Section 26 3600 - Transfer Switches
- Q. Section 28 4600 - Fire Detection and Alarm

1.03 TESTING CRITERIA

- A. General:
 - 1. Perform field tests and operational checks to assure that all electrical equipment, both contractor and Owner supplied, is operational within industry and manufacturer's tolerances, and is installed in accordance with design specifications.
 - 2. Provide tests and operational checks to determine the suitability for energization.
 - 3. Schedule tests and give a minimum of one week's advance notice of time and date to the Architect and Owner for any major systems tests specified in this Section.
 - 4. Provide testing company equipment and technical personnel to perform tests and inspections. At Contractors expense, furnish any personnel necessary to assist in the testing and inspection.
 - 5. When tests and inspections are complete, attach a label to the devices tested. Provide on the label, the name of the testing company, date of tests, and initials of the Engineer who performed the tests.
- B. Responsibilities:
 - 1. Clean the equipment, torque down accessible bolts according to the equipment manufacturer's instructions; perform routine insulation resistance tests on branch and feeder circuits, continuity checks on branch and control wiring, and rotation tests for distribution and utilization equipment.

2. Furnish a complete set of current plans and specifications to the testing company prior to commencement of testing. At each test site, provide test control power necessary to perform the tests specified. Consult the test organization as to the specific power requirements. Notify the testing organization when the equipment and systems are ready for their inspections and testing. After review by the testing engineer, correct deficiencies noted by the testing company.
 3. Responsible for having the manufacturer of each equipment and/or system provide factory trained representatives(s) that will perform required functional testing, checkout, and repairs in order to pronounce the equipment and/or systems meet the requirements of these specifications and Drawings and it is ready for startup testing and commissioning by the testing organization as specified hereafter.
 4. Furnish settings of protective devices by the Engineer, in conjunction with Utility.
 5. Testing organization to notify Engineer prior to the commencement of testing. The testing organization, set, and adjust the protective devices and associated auxiliary timing devices in accordance with the values furnished by the Engineer. The testing organization maintains a written record of tests and, upon completion of the test, include them in a final report. Detail deficiencies in the system material, workmanship, or design.
- C. Implementation:
1. Safety practices comply with applicable state and local safety orders, as well as with the Occupational Safety and Health Act (OSHA). Compliance with the National Fire Protection Association (NFPA) standard NFPA 70E, and the Accident Prevention Manual for Industrial Operations of the National Safety Council.
 2. Tests, other than phase rotation and operational tests, only performed on apparatus that is deenergized. The testing company's lead test engineer for the project designated safety representative and supervise testing observations and safety requirements. Do not proceed with Work until determined that it is safe to do so.
 3. Power Circuits: Conductors shorted to ground by a hotline grounding device approved for the purpose. Provide warning signs and protective barriers as necessary to conduct the tests safely.
- D. Reports:
1. General: Provide full documentation of tests in the form of a report.
 2. Test report includes the following sections:
 - a. Scope of Testing
 - b. Equipment Tested
 - c. Description of Test
 - d. Test Results
 - e. Conclusions and Recommendations
 - f. Appendix, including Test Forms
 3. Record each piece of equipment on a data sheet listing the condition of the equipment as found and as left. Include recommendations for necessary repair and/or replacement parts. Indicate on data sheets the name of the engineer who tested the equipment and the date of the test completion.
 4. Submit record copies of the completed test report no more than 30 days after completion of the testing and inspection.

1.04 REFERENCES

- A. The testing and inspection comply with applicable sections of the applicable codes and standards listed in Section 26 0500 - Common Work Results for Electrical of the project specifications.

- B. The inspection and testing comply with the project plans and specifications, as well as with the manufacturer's drawings, instruction manuals, and other applicable data that may be provided by the Engineer, for the apparatus tested.

1.05 QUALIFICATIONS

- A. Testing Organization:
 - 1. Independent division of the manufacturer of the assembled products being tested. If an outside testing organization is utilized, a representative of the manufacturer under contract by the testing company. Be present during testing to ensure the testing is performed properly and deficiencies discovered are promptly corrected.
 - 2. Full Service Company that employs factory trained test engineers capable of troubleshooting, as well as identifying power equipment problems.
 - 3. Perform Work outlined under the full time, onsite supervision of a graduate engineer with a minimum of 5 years of field testing experience.
 - 4. Upon request, submit proof of its qualifications.

PART 2 PRODUCTS

2.01 TESTING EQUIPMENT

- A. Testing agency to have calibration program, which maintains applicable test instrumentation within rated accuracy. Traceable accuracy to the National Bureau of Standards in an unbroken chain. Calibrate instruments calibrated in accordance with the following frequency schedule:
 - 1. Field Instruments: 6 month maximum.
 - 2. Laboratory Instruments: 12 months.
 - 3. Leased Specialty Equipment: 12 months (where accuracy is guaranteed by lessor). Dated calibration labels visible on test equipment.

PART 3 EXECUTION

3.01 EQUIPMENT TO BE TESTED

- A. Section 26 0513 - Medium-Voltage Cables:
 - 1. Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Medium Voltage Cable, Section 7.3.3.
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables:
 - 1. For circuits rated 400A or higher perform tests listed in the NETA 2017 Acceptance Testing Specifications for Low-Voltage Cables, Section 7.3.2.
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems :
 - 1. Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Grounding Systems, Section 7.13.
- D. Section 26 1116 - Secondary Unit Substations :
 - 1. Switchgear: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Switchgear and Switchboard Assemblies, Section 7.1.
 - 2. Transformers: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Transformers, Section 7.2.1.2.
 - 3. Circuit Breakers: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Low-Voltage Power Circuit Breakers, Section 7.6.1.2.
 - 4. Ground-Fault Protection Systems: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Ground-Fault Protection Systems, Section 7.14
- E. Section 26 1300 - Medium-Voltage Switchgear :
 - 1. Switchgear: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Switchgear and Switchboard Assemblies, Section 7.1.
 - 2. Circuit Breakers: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Vacuum Medium Voltage Circuit Breakers, Section 7.6.2.3.

3. Protective Relays: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Protective Relays, Section 7.9, using the tests applicable to each relay based on its protective functions.
 4. Instrument Transformers: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Instrument Transformers, Section 7.10.
 5. Station Batteries: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Direct Current Systems, Sections 7.18.1 and 7.18.2.
 6. Lightning Arresters: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Surge Arresters, Section 7.19.
- F. Section 26 2413 - Switchboards:
1. Switchboards: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Switchgear and Switchboard Assemblies, Section 7.1.
 2. Circuit Breakers: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Low-Voltage Circuit Breakers, Section 7.6.1.1.
- G. Section 26 2416 - Panelboards:
1. Panelboards: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Switchgear and Switchboard Assemblies, Section 7.1. Only those tests applicable to panelboards need be performed, no electrical tests of the circuit breakers need to be performed.
- H. Section 26 2713 - Electricity Metering:
1. Instrument Transformers: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Instrument Transformers, Section 7.10.
 2. Metering Functions: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Metering, Section 7.11.
- I. Section 26 2913 - Enclosed Controllers
- J. Section 26 3353 - Static Uninterruptible Power Supply:
1. UPS Systems: Perform tests listed in Section 26 33 53, Static Uninterruptible Power Supply.
- K. Section 26 3600 - Transfer Switches:
1. Transfer Switches: Perform tests listed in the NETA 2017 Acceptance Testing Specifications for Automatic Transfer Switches, Section 7.22.3.
- L. Section 28 4600 - Fire Detection and Alarm:
1. Fire Alarm System: Perform tests listed in Section 28 4600 - Fire Detection and Alarm .

END OF SECTION 26 0580

**SECTION 26 0583
WIRING CONNECTIONS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

- A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 0533.13 - Conduit for Electrical Systems.
- C. Section 26 0533.16 - Boxes for Electrical Systems.
- D. Section 26 2726 - Wiring Devices.
- E. Section 26 2816.16 - Enclosed Switches.

1.03 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices.
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- C. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Comply with NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Disconnect Switches: As specified in Section 26 2816.16 and in individual equipment sections.
- C. Wiring Devices: As specified in Section 26 2726.
- D. Flexible Conduit: As specified in Section 26 0533.13.
- E. Wire and Cable: As specified in Section 26 0519.
- F. Boxes: As specified in Section 26 0533.16.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
- J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION 26 0583

**SECTION 26 0923
LIGHTING CONTROL DEVICES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Control Stations.
- B. Standalone Room Controllers.
- C. Occupancy/Vacancy Sensors.
- D. Photosensor.
- E. Relays, Switchpacks, and Room Controllers.
- F. Power Supplies and Transformers.
- G. Emergency Lighting Control Relays.
- H. Low Voltage Control Wiring.
- I. Test Equipment.
 - 1. Responsibilities and participation under Division 26, Electrical in the automatic dimming system installation and commissioning process.
 - 2. Installation, connection, adjustment, and testing of the equipment including labor, materials, tools, appliances,

1.02 GENERAL REQUIREMENTS

- A. Provide qualified personnel for participation in commissioning tests, including seasonal testing required after the initial commissioning.
- B. Providing equipment, materials, and labor necessary to correct deficiencies found during the commission process which fulfill contract and warranty requirements.
- C. Provide Operating and Maintenance Data and Record Drawings to the Test Engineer for verification, organization, and distribution.
- D. Provide assistance to the Test Engineer to develop and edit descriptions of system operation.
- E. Providing training for the systems specified in this Division with coordination by the Test Engineer and Commissioning Agent.

1.03 SUBMITTALS

- A. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, installed features, system wiring schematics, and user interface components.
- B. Shop Drawings:
 - 1. Submittal drawings with a complete system diagram to show quantity of devices, location in the building, dimensions and required wiring.
 - 2. Occupancy sensors, show the required quantity to cover the space controlled (note: this may be more than the quantity shown on the drawings).
 - 3. The locations shown on the drawings are for reference only and coordinated with the manufacturer and Architect for final quantity and location during the bid process to allow for allowance of proper quantity, wiring lengths and installation coordination.
- C. Samples:
 - 1. Provide physical samples of user interface devices and visually exposed control devices for approval by Owner and Architect.
- D. Operation and Maintenance Manuals:
 - 1. Include product data of system components, one line diagrams of installed components and their locations throughout the building, a final floor plan noting the locations of devices installed above ceilings, behind access panels or in concealed but accessible spaces and the lighting zones or devices they control.

2. Final relay schedule with the zone of control, location of control zone, voltage, power feed, time clock setting, photocell set point, switch, or dimmer stations controlling the relay, and sweep function set points will be provided by the Contractor.
- E. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.04 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.06 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.07 SYSTEM DESCRIPTION

- A. Control Stations:
 1. Control Station Types:
 - a. Provide control stations for occupant lighting control as scheduled on the drawings and may include and/or combine the following type of individual control type within a single station:
 - 1) Scene Selection
 - 2) On/Off Switching
 - 3) Dimming Raise/Lower
 - 4) Occupancy/Vacancy Sensor
- B. Relays, Switchpacks, and Room Controllers:
 1. Analog and Digital: Room controller devices to accept line voltage input as well as input from any combination of control stations, occupancy/vacancy sensors and/or daylight sensors and produce the required effect (switching or dimming) on up to four zones of connected lighting.
- C. Occupancy/Vacancy Sensing:
 1. Reduce electric energy consumption by reducing or eliminating lighting energy use in unoccupied spaces by switching lighting off with occupancy and/or vacancy sensors.
- D. Photoelectric Daylight Harvesting:
 1. Daylit Areas:
 - a. Reduce electric energy consumption during daylight hours by reducing the light output of the electric lighting system via switching in response to measured lighting levels provided by daylight within the building interior.
 - b. Dimming zones will correlate with the distribution of daylight within the space as noted on plans.
- E. Emergence Override: Provide automatic load control relay devices for controlling egress lighting circuiting.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

- A. Basis of Design Manufacturer:
 - 1. Cooper Controls (Greengate, Fifth Light)
 - 2. Wattstopper
 - 3. Lutron
 - 4. Acuity Controls (nLight, LC&D, Sensor Switch)
 - 5. PLC Multipoint
 - 6. Hubbell
 - 7. Encelium
- B. Approved Basis of Design Alternate Manufacturers:
 - 1. Cooper Controls
 - 2. Wattstopper
 - 3. Lutron
 - 4. Acuity Controls (nLight, LC&D, Sensor Switch)
 - 5. PLC Multipoint
 - 6. Hubbell
 - 7. Encelium
- C. Products described in this section are to be provided by the single BOD (basis of design) or approved alternate manufacturer listed above, or by a compatible, BOD approved third party alternate manufacturer.
 - 1. Manufacturer series numbers are identified herein to establish the minimum level of quality for each product.
 - 2. Comparable products that meet the requirements of the specification by other acceptable manufacturers identified herein are acceptable with prior approval.

2.02 CONTROL STATIONS

- A. Control Station Types:
 - 1. Scene Select: Provide five scene selection control station including discrete, engraveable pushbuttons allowing on/off and raise/lower control of entire space and means for occupants to select from five scenes.
 - 2. On/Off:
 - a. Provide individual pushbuttons.
 - b. Controls lighting in entire space if no zones indicated on plans.
 - 3. Dimming/Raise Lower:
 - a. Provide individual pushbuttons for on and off control of zones indicated on plans.
 - b. Controls lighting in entire space if no zones indicated on plans.
 - c. Dimming accomplished by press and hold the ON and OFF buttons for dimming up and down respectively.
 - 4. Integral Occupancy:
 - a. Automatically switches lighting on when occupant enters space.
 - b. Switches lights off after predetermined period of vacancy.
 - c. Controls lighting in entire space.
 - 5. Integral Vacancy:
 - a. Includes pushbuttons for occupant manual on/off and dimming control of lighting in space.
 - b. Automatically switches lights off after predetermined period of vacancy.
 - c. Includes provision to revert to occupancy control in absence of configurable amount of daylight.
 - d. Controls lighting in entire space.

- B. Line Voltage Dimming Switches:
 - 1. Architectural grade, line voltage, 20A rated, single pole, preset style, slide up to brighten and down to dim, with on/off rocker style switch, decora style, wattage rating and lamp/power supply compatibility as required.
 - 2. Forward Phase, Reverse Phase, 0-10V.
 - 3. Provide 3-way type where shown on plan.
 - 4. Lutron Diva Series
- C. Wallbox Occupancy Sensor Switches:
 - 1. 180 degree coverage, type as shown on plan (PIR, ultrasonic or dual-technology), configurable automatic-on or manual on operation, 3-wire type, daylight override, adjustable time-out, selectable walk-through mode and override off switch. Single or dual relay type as required or as shown on Drawings.
 - 2. Provide 3-way type where shown on plan.
 - 3. WattStopper PW series.
- D. Digital Control Stations:
 - 1. Provide control stations with configuration as indicated or as required to control the loads as indicated.
 - 2. General Requirements:
 - a. Power: Class 2 (low voltage).
 - b. UL listed.
 - c. Provide faceplates with concealed mounting hardware, with matching finish.
 - d. Borders, logos, and graduations to use laser engraving or silk-screened graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning. Self-Adhesive labels not permitted.
 - e. Finish: As specified for wall controls in this Section.
 - 3. Single-Zone or Single-Group:
 - a. Turn an individual fixture or group of fixtures as shown on plans on and off via button press.
 - b. Raise and lower light levels via press and hold button.
 - 1) Separate buttons for dimming and on/off functions not allowed.
 - 4. Multi-Scene or Multi-Group:
 - a. General Requirements:
 - 1) Allows control of any devices part of the lighting control system as indicated on plans.
 - 2) Controls can be programmed with different functionality through system software without any hardware changes. Allows contextual functions based upon button press and press and hold input.
 - 3) Allows for easy reprogramming without hardware replacement.
 - 4) System will automatically update programming without direct human interaction upon replacement of any component.
 - 5) Communications: Utilize RS485 or similar wiring for low-voltage communication.
 - 6) To help occupants understand how to use the lighting control system, engraving requirements should be included for controls. Engraving details should include text size and style.
 - 7) Engrave keypads with button, zone, and scene descriptions as indicated on the drawings.
 - 8) Software Configuration:
 - (a) Single defined action.
 - (b) Buttons can be programmed to perform defined action on press and defined action on release.

- (c) Buttons can be programmed using conditional logic off of a state variable such as time of day or partition status.
- (d) Buttons can be programmed to perform automatic sequence of defined actions.
- (e) Capable of deactivating select keypads to prevent accidental and/or unwanted changes to light levels and other settings.
- (f) Buttons can be programmed for raise/lower of defined loads.
- (g) Buttons can be programmed to toggle defined set of loads on/off.
- 9) Status LEDs:
 - (a) Upon button press, LEDs to immediately illuminate.
 - (b) Time delays inherent in large systems can cause short delays between button press and system confirmation. To avoid any confusion and prevent multiple button presses, keypads should immediately show that the button has been pressed for visual confirmation.
 - (c) LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or LEDs to turn off if the button press was not processed.
 - (d) Support logic that defines when LED is illuminated:
 - (e) Scene logic (logic is true when zones are at defined levels).
 - (f) Room logic (logic is true when at least one zone is on).
 - (g) Pathway logic (logic is true when at least one zone is on).
 - (h) Last scene (logic is true when spaces are in defined scenes).
- b. Wired Keypads:
 - 1) Style:
 - (a) Mounting: Wall box or low-voltage mounting bracket; provide wall plates with concealed mounting hardware.
 - 2) Design keypads to allow field-customization of button color, configuration, and engraving using field-changeable replacement kits.
 - 3) Terminal block/connector inputs to be over-voltage and miswire-protected against wire reversals and shorts.
 - 4) LEDs next to each button are used during programming and provide feedback when the buttons are pressed.
 - 5) Available with status LEDs.
 - 6) Available in several button configurations and finishes.
 - 7) Four Scene Control:
 - (a) On, four scenes, and off with master raise/lower.
 - (1) Four LEDs for night light and secondary color to indicate programming mode.
 - (2) Recall four scenes plus on or off for one group of fixtures.
 - (3) Master raise/lower control for entire group of fixtures.
 - (4) Immediate local LED response upon button activation to indicate that a system command has been requested.

2.03 STANDALONE ROOM CONTROLLERS

A. General:

1. Provides a common, standalone interface via dimming and/or switching to a group of 0-10V Dimming or Fixed Output Ballasts and/or 0-10V LED Drivers.
2. Direct conduit connection or provision for mounting to junction box.
3. Physical barriers provided between Class 1 and Class 2 wiring as well as between normal power and emergency power wiring.

4. Dual voltage 120/277V, 60HZ operation, 20A rating for each relay Relays utilize zero crossing technology for increased life.
 5. Plenum Rated.
- B. Digital Room Controllers and Switchpacks:
1. Replacement of any component requires no reconfiguration or reprogramming.
 2. Low voltage connections via CAT5/6 and RJ-45 connectors.
 3. On board power supply for a minimum of six accessory devices including, but not limited to occupancy sensors and control stations.
 4. Up to four on-board relays and accompanying 0-10V dimming channels.
 5. Provision for IR or RF remote for configuration and editing of connected device settings.
 - a. Provide means to copy settings from on system to another.
 6. Field configurable to support, occupancy (automatic on) and vacancy (manual on) control protocol. Daylight harvesting feature for any number of zones.
 7. Timeclock Functionality:
 - a. Provide functionality to directly trigger relay and dimmer settings by timeclock event and:
 - b. Mask or lock out sensor and/or control station inputs by timeclock event.
 8. Room Controller: WattStopper LMRC Series
 9. Switchpack: WattStopper LMZC Series
- C. Analog Room Controllers and Power Packs:
1. On board power supply for a minimum of six accessory devices including, but not limited to occupancy sensors.
 2. Up to four on-board relays and accompanying 0-10V dimming channels.
 3. Provision for IR or RF remote for configuration and editing of connected device settings.
 - a. Provide means to copy settings from on system to another.
 4. Field configurable to support, occupancy (automatic on) and vacancy (manual on) control protocol with optional daylight harvesting feature.

2.04 OCCUPANCY/VACANCY SENSORS

- A. General Requirements:
1. Power Failure Memory: Settings and learned parameters to be saved in non-volatile memory and not lost should power be interrupted and subsequently restored.
 2. Furnished with necessary mounting hardware and instructions.
 3. NEC Class 1 or 2 devices, refer to plans.
 4. Ceiling-Mounted Sensors: Indicate viewing directions on mounting bracket.
 5. Wall-Mounted Sensors: Provide swivel-mount base.
 6. Ceiling-Mounted Sensors: Provide customizable mask to block off unwanted viewing areas.
 7. Isolated Relay: Provide ceiling mounted sensors with an internal isolated relay with Normally Open, Normally Closed, and Common outputs rated at 1A at 30VDC/VAC for use with HVAC control, Data Logging and other control options.
 8. Line Voltage sensors accept line voltage input and output switched line voltage directly to controlled luminaires.
 - a. Line voltage sensors must be capable of occupancy or vacancy control. Operation is to be determined by onboard device settings.
 - b. Sensor configuration to be made by integral pushbutton or dial controls.
 - c. Types:
 - 1) PIR: utilize invisible light to determine occupancy.
 - 2) Ultrasonic/Microphonic: utilize audible or subaudible sound to determine occupancy.

- 3) Dual-Tech: utilize a combination of the above technologies to determine occupancy.
 - (a) Detection of vacancy by both ultrasonic and PIR sensors required to turn lights off.
9. Low Voltage sensors are paired with a switch pack or room controller. Provide digital sensors compatible with room controller/switchpack and balance of system.
 - a. Low voltage sensors must be capable of occupancy or vacancy control. Operation is to be determined by overall system configuration and/or device settings.
 - b. Sensor configuration to be made by wireless handheld configuration tool by integral pushbutton.
 - c. Types:
 - 1) PIR: utilize invisible light to determine occupancy.
 - 2) Ultrasonic/Microphonic: Utilize audible or sub-audible sound to determine occupancy.
 - 3) Dual-Tech: Utilize a combination of the above technologies to determine occupancy.
 - (a) Detection of vacancy by both ultrasonic and PIR sensors required to turn lights off.
- B. Ceiling Mounted: 360 degree coverage:
 1. Automatic-on operation, light-level sensing, adjustable time-out, automatic sensing/adjustment for optimal time-out delay setting, selectable walk-through mode.
 2. Low- or line-voltage as shown on Drawings or described in Section 26 0993 - Sequence of Operations for Lighting Controls,
 3. Surface mounted, provide power packs as required.
 - a. Dual Technology Type:
 - 1) Low Voltage: WattStopper DT-300 Series.
 - 2) Line Voltage: WattStopper DT-355 Series
 - b. Passive infrared type:
 - 1) Low Voltage: WattStopper CI-300 Series
 - 2) Line Voltage: WattStopper CI-355 Series
 - c. Ultrasonic type:
 - 1) Low Voltage: WattStopper UT-300 Series
 - 2) Line Voltage: WattStopper UT-355 Series
- C. Ceiling/Wall Mounted/Corner: 180 degree coverage:
 1. Automatic-on operation, light-level sensing, adjustable time-out, automatic sensing/adjustment for optimal time-out delay setting, selectable walk-through mode,
 2. Low-voltage with power pack, surface mounted as required.
 - a. Dual Technology type: WattStopper DT-200 series.
 - b. Passive infrared type: WattStopper CX-100 series.
- D. Provide multiple contacts and/or power packs for Low Voltage occupancy sensors that:
 1. Control both normal and emergency lighting and require separation of branch circuit wiring systems. In case of occupancy sensor failure, emergency lighting fail to the on state.
 2. Control separate lighting control zones. Unless otherwise noted, occupancy sensors are intended to control light in a designated zone or room. Contractor is responsible for providing the required power packs to insure functionality of the system.
 3. Provide UL924 listed relay or power pack for to bypass occupancy sensors in event of power failure. During normal operation, relay to operate lighting in conjunction with adjacent normal power lighting.
- E. Low Temperature/Wet Location Occupancy Sensor: 1. Provide line voltage occupancy sensors where shown on plans.

1. Automatic-on operation, light-level sensing, adjustable time-out, automatic sensing/adjustment for optimal time-out delay setting, selectable walk-through mode.
 2. Temperature Range at least -40 degrees F to +95 degrees F. With a minimum IP 65 rating.
 3. Surface mounted, provide auxiliary contacts if required.
 - a. Passive infrared type: WattStopper CB-100 Series
- F. High Ceiling Occupancy Sensor:
1. Provide low or line voltage occupancy sensors where shown on plans.
 2. Automatic-on or manual-on operation, light-level sensing, adjustable time-out, automatic sensing/adjustment for optimal time-out delay setting, selectable walk-through mode.
 3. Suitable for mounting heights from 12-feet-40-feet.
 4. Surface mounted, provide auxiliary contacts if required.
 - a. Passive infrared type: WattStopper HB Series

2.05 PHOTOSENSOR

- A. General Requirements:
1. Use NEC Class 2 wiring for low voltage communication.
 2. Can be replaced without reprogramming.
 3. Photopically corrected to approximate human vision.
 4. Daylight sensing equipment will be digital, full range type, self or manually calibrated.
 5. Provide proper photocell type(s) as required to:
 - a. Measure lighting levels on an affected interior surface. Illumination contribution to this measured surface will include both daylighting and electric lighting (closed-loop system).
 - b. Measure light levels entering space through glazing. Illumination contribution to this measured surface will include daylighting only (open-loop system).
 - c. Measure light levels on affected interior surface and entering space through glazing. Illumination contribution to these measured surfaces will include both daylight and electric lighting (combination open and closed loop/dual loop system).
 6. Independently control single zone of luminaires for maximum energy savings while maintaining even task illumination across the entire area between zones. Refer to drawings for control groupings.
 7. Incorporate time delay logic to prevent cycling due to clouds and other short-term influences to lighting levels.
 8. Accept indoor, skylight, and outdoor photo sensing heads. Photo sensing control permit the user to specify the actual footcandle level where desired switching occurs.
- B. Indoor:
1. Stable output over temperature from 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C).
 2. Open Loop:
 - a. Adjustable aiming angle to accommodate various glazing configurations
 - b. Provide linear response from 0 to minimum 1000 foot-candles.
 - c. Mountable on lighting fixtures or recessed acoustical ceiling tiles.
 - d. Wattstopper LMLS-500 Series.
 3. Closed Loop:
 - a. Indoor sensors have a Fresnel lens, with a minimum 60 degree cone of response.
 - b. Provide linear response from 0 to minimum 500 foot-candles.
 - c. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
 - d. Mountable on lighting fixtures or recessed acoustical ceiling tiles.
 - e. Wattstopper LMLS-400 Series.

4. Dual Loop (Skylight/Atrium):
 - a. Indoor sensors have a Fresnel lens, with a minimum 60 degree cone of response.
 - b. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
 - c. Atrium:
 - 1) Translucent dome with a 180 degree field of view.
 - 2) Sensor range from 2 to 2,500 FC.
 - d. Skylight:
 - 1) Sensors have a translucent dome with a 180 degree field of view.
 - 2) Range between 10 and 7,500 FC.
 - e. Wattstopper LMLS-600 Series.
- C. Outdoor / Rooftop:
 1. Outdoor models have a hood over the aperture to shield the sensor from direct sunlight.
 2. The outdoor sensor circuitry completely encased in an optically clear epoxy resin.
 3. Range between 0 and 750 FC.
- D. Analog: Interior/Exterior: PLC CES Series

2.06 RELAYS, SWITCHPACKS AND ROOM CONTROLLERS

- A. Analog:
 1. Devices interconnected via low voltage cabling.
 2. Configurable to produce the following sequences of operation by handheld IR or RF remote.
 - a. Occupancy control: Automatically turns lights on when occupant is detected in space. Automatically turns lights off after a configurable period of vacancy.
 - b. Vacancy Control: Occupant must manually turn lights in space on, automatically turns lights off after a configurable period of vacancy.
 - c. Timeclock
 - d. Daylight Harvesting:
 - 1) Occupant must manually turn lights in space on, automatically turns lights off after a configurable period of vacancy.
 - 2) Accepts input from analog daylight sensing equipment and adjusts light level settings accordingly.
- B. Digital:
 1. Devices interconnected by contractor terminated cabling.
 2. Configurable to produce the following sequences of operation by handheld IR or RF remote.
 - a. Occupancy Control:
 - 1) Automatically turns lights on when occupant is detected in space.
 - 2) Automatically turns lights off after a configurable period of vacancy.
 - b. Vacancy Control: Occupant must manually turn lights in space on, automatically turns lights off after a configurable period of vacancy.
 - c. Timeclock
 - d. Daylight Harvesting
 - 1) Occupant must manually turn lights in space on, automatically turns lights off after a set period of vacancy.
 - 2) Accepts input from daylight sensing equipment and adjusts light level settings accordingly.
 3. Provides additional capability or accessories to integrate with AV, BAS, HVAC, and/or shade control systems.

2.07 POWER SUPPLIES AND TRANSFORMERS

- A. Provide from same manufacturer of equipment served.
- B. Compatible with specified photocells and dimming control station protocols.
- C. Refer to Section 26 5000 - Lighting for product specification on luminaire power supplies and transformers.

2.08 EMERGENCY LIGHTING CONTROL RELAYS

- A. Manufacturers:
 - 1. Bodine
 - 2. Nine 24
 - 3. Wattstopper
 - 4. Or approved equivalent.
- B. General Requirements
 - 1. Comply with UL 924 requirements:
 - a. If controlled off, must turn on automatically.
 - b. Provide required egress illuminance along entire egress path.
 - c. Must not be able to be overridden by building occupants.
 - 2. Unless shown otherwise on drawings, load control relay provided is to control egress lighting along with adjacent normal power lighting except in event of power failure or fire alarm system alarm status.
 - 3. Device can be integral to other components listed above or operate in conjunction with other lighting control components as a discrete component, but must be fed via UL 1008 compliant power source, such that in event of a power failure, control and dimming signals are bypassed and lighting operates at full power. Fed via the UL 1008 source.
- C. Description:
 - 1. Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts.
 - 2. UL 924 listed for connected load of 10A at 277V or 120V.
 - 3. UL rated N.C. contacts, minimum 10A rating.
 - 4. Integral surge protection.
 - 5. Two separate status emergency lighting indicators for troubleshooting:
 - a. Amber LED indicates presence of normal utility power.
 - b. Red LED indicates presence of unswitched emergency power.
 - 6. Manual and/or automatic diagnostic testing feature.
 - 7. Self-contained enclosure UL listed for installation in indoor or damp locations.

2.09 LOW VOLTAGE CONTROL WIRING

- A. 18 gauge shielded cable or as recommended by the manufacturer.

2.10 TEST EQUIPMENT

- A. Provide multi-function digital illuminance meter with detachable receptor head with the following characteristics:
 - 1. Receptor: Silicon photocell type
 - 2. Illuminance Units: Lux or footcandles (switchable)
 - 3. Measuring range: 0.1 to 19,990 lux, 0.01 to 1,999 footcandles
 - 4. Accuracy: ± 4 percent ± 1 digit of displayed value
 - 5. Cosine Correction Characteristics: Within ± 1 percent at 10 degrees; within ± 5 percent at 60 degrees.
 - 6. Measuring functions: Illuminance, integrated illuminance, average illuminance.
 - 7. Temperature/humidity drift: Within ± 3 percent ± 1 digit (of value displayed at 68 degrees F) within operating temperature/humidity range.

8. Operating conditions: 32 degrees F to 104 degrees F at less than 85 percent humidity.
- B. Provide proof of calibration within 12 months of use. Calibration performed by an independent calibration lab approved by the manufacturer of the meter.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Submittal data required prior to ordering and installation.
- B. General Testing:
 1. Functionally test control devices to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved drawings, specifications, and manufacturers' installation instructions.
 2. Prepare and complete report of test procedures and results and file with the Owner.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- E. Install lighting control devices plumb and level, and held securely in place.
- F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 2726.
- G. Provide required supports in accordance with Section 26 0529.
- H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- I. Identify lighting control devices in accordance with Section 26 0553.
- J. Low Voltage Wiring:
 1. Install in conduit where running through inaccessible areas. Provide plenum rated wiring in accessible ceiling spaces.
 2. Test CAT5/6 cables terminated on site prior to wiring of digital lighting control systems. Provide evidence of successful testing to Engineer and Owner. Factory pre-terminated cabling is not subject to this requirement.
 3. Coordinate low voltage wiring connection and location with luminaires to be controlled.
- K. Occupancy Sensors:
 1. For installation of low voltage occupancy sensors in inaccessible ceiling systems, coordinate power pack locations with Architect prior to installation and coordinate access panel locations with Architect.
 2. Sensor locations identified on Drawings are diagrammatic and are meant to indicate only that occupancy sensing within a given space is required. Locate sensors as required by the manufacturer to provide maximum coverage of the room, to operate as someone enters the room, and to avoid false operation due to persons outside the room passing an open door.
 - a. Provide additional sensing heads as necessary or per manufacturer's recommendation to achieve complete coverage of each room.
 3. Set sensitivity as required to provide small movement coverage throughout the room without extending coverage beyond the room.
 4. System performance testing done with the sensor timing set to the time delay indicated by space type in Section 26 0993 - Sequence of Operations for Lighting Controls.
 5. Upon Completion of installation and prior to turning space over to Owner, Contractor reset occupancy sensor automatic self-adjustment settings to insure proper time delay self-adjustment for Owner occupant schedule and room use.

6. Allow for up to 24 hours of callback sensor adjustments to be made by the Contractor or occupancy sensor manufacturer qualified installer for up to six months after the Owner has taken occupancy of the space.
- L. Emergency Lighting Control Relays:
 1. Provide unswitched emergency circuit, and unswitched and switched normal circuit to UL 924 relay for control of emergency luminaires with remaining room luminaires on normal power.
 2. Install each relay within dedicated 4-11/16-inch junction box with double-gang plaster ring for wall or ceiling flush-mount or in a self-contained enclosure from the manufacturer, as indicated on Drawings.
 3. Where location in ceiling would interfere with removal of ceiling tiles, install relay flush-mounted in nearest wall at ceiling level.
 4. Do not locate behind wall switch.

3.02 WORK PRIOR TO COMMISSIONING

- A. Complete phases of work so the system can be powered, tested, adjusted, and otherwise commissioned. Under Division 26, Electrical, complete systems, including subsystems, so they are fully functional. This includes the complete installation of equipment, materials, wire, controls, etc., in accordance with the contract documents and related directives, clarifications, change orders, etc.
- B. A commissioning plan will be developed by the Test Engineer and approved by the Commissioning Agent. Under Division 26, Electrical, assist the Test Engineer and Commissioning Agent in preparing the commissioning plan by providing necessary information pertaining to the actual equipment and installation. If system modifications and clarifications are in the contractual requirements of this and related sections of work, they will be made at no additional cost to the Owner. If Contractor initiated system changes have been made that alter the commissioning process, the Commissioning Agent will notify the Owner.
- C. Specific pre-commissioning responsibilities under Division 26, Electrical are as follows:
 1. Factory startup services for the following items of equipment:
 - a. Lighting Control System
 2. Normal startup services required to bring each system into a fully operational state. This includes complete installation and cleaning. The Test Engineer will not begin the commissioning process until each system is documented as being installed complete.
- D. Begin commissioning after installation of interior and exterior finishes including but not limited to adjacent roofing, finished floor, wall, and ceiling systems including final painting, furniture and book stacks in place, and other building systems which have direct or indirect influence on the performance and distribution of the daylight and electric lighting systems.
- E. Start of commissioning before such items are complete will not relieve Contractor from completing those systems in accordance with the Construction Schedule.

3.03 SEQUENCE OF COMMISSIONING

- A. Provide to Architect prior to start of commissioning layout drawings indicating proposed location of measurement points. Proceed with commissioning after review and acceptance by Architect.
- B. Illuminance measurements oriented horizontal, facing up, at 30-inches above finished floor. Measurements for a control group occurs at the same location. Ensure constancy of local surface reflectance conditions throughout commissioning of each control group.
- C. Ensure no personnel or outside influence affects the amount of flux striking the receptor head during the recording session.
- D. Document measurements in clearly understandable format for review by the Architect. Include time of measurement, temperature, and relative humidity.

- E. Measure illuminance at least two hours after local sunset with full output of electric lighting. Record integrated illuminance and average illuminance for a 2 hour period.
- F. During daylight hours, measure illuminance with electric lighting off, including emergency and nightlight circuits. Record integrated illuminance and average illuminance for a two hour period. Document in clearly understandable format for review by the Architect.
- G. Set each photocell to 150 percent of electric-only lighting contribution.
- H. After initial setpoint has been set, measure illuminance in 10 minute increments from 1 hour before to 1 hour after local sunset.
- I. Submit recorded data to Architect for review.

3.04 TESTING FOR SEASONAL VARIATIONS

- A. Timing of Commissioning:
 - 1. Initial Commissioning:
 - a. Perform to best suit the current time-of-year and cloud cover conditions.
 - b. Conduct as done as soon as contract work is completed regardless of season.
 - 2. Seasonal Commissioning: Test under full sunlight and full overcast conditions during summer and winter solstice, as well as similar conditions at the spring or fall equinox.
 - 3. Subsequent Commissioning: Ascertain adequate performance during the four seasons.

3.05 PARTICIPATION IN COMMISSIONING

- A. Provide skilled technicians to start up systems within Division 26, Electrical. The same technicians made available to assist the Test Engineer and Commissioning Agent in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested, and coordinated by the Test Engineer. Under Division 26, Electrical, ensure that the qualified technician(s) are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments, and problem resolutions at no additional cost to the Owner.
- B. System problems and discrepancies may require additional technician time, Test Engineer time, Commissioning Agent time, redesign, and reconstruction of systems and system components. The additional technician time made available for the subsequent commissioning periods until the required system performance is obtained at no additional cost to the Owner.
- C. Commissioning Agent reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment or system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service the commission the equipment, and a willingness to work with the Test Engineer and Commissioning Agent to get the job done. Remove technicians from the project at the request of either the Test Engineer or Commissioning Agent.

3.06 RESOLUTION OF DEFICIENCIES

- A. In some systems, misadjustments, misapplied equipment, and deficient performance will result in additional work required to commission the systems.
- B. Complete work under the direction of the Architect, with input from the Contractor, equipment supplier, Test Engineer, and Commissioning Agent.
- C. Whereas members will have input and the opportunity to discuss the work and resolve problems, the Architect will have final jurisdiction on the necessary work to be done to achieve performance.
- D. Complete corrective work in a timely fashion to permit timely completion of the commissioning process.

- E. Experimentation to render system performance is permitted. If the Commissioning Agent deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Agent will notify the Owner, indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities.
- F. If deadlines pass without resolution of the problem, the Owner reserves the right to obtain supplementary services, equipment, or both, to resolve the problem.
- G. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

3.07 TRAINING

- A. Participate in the training of Owner's engineering and maintenance staff, as required in Divisions 01 through 28, on each system and related components.
- B. Conduct training in a classroom setting, with system and component documentation, and suitable classroom training aids.
- C. Training classroom sessions and file demonstrations will be videotaped and copies of this material will be provided as part of closeout requirements.
- D. Training will be conducted jointly by the test engineer, commissioning agent, the Contractor, and the equipment suppliers.
- E. Test engineer responsible for highlighting system peculiarities specific to this project.

3.08 SYSTEMS DOCUMENTATION

- A. In addition to the requirements of Division 01, General Requirements, update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations.
- B. Division 26, Electrical, record drawings include architectural floor plans and the individual daylight control systems in relation to actual building layout.
- C. Provide in AutoCAD .dwg format for transmittal to the test engineer.

END OF SECTION 26 0923

SECTION 26 0993
SEQUENCE OF OPERATIONS FOR LIGHTING CONTROLS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Abbreviations and Definitions
 - 2. General Controls Approach
 - 3. Space-by-Space Sequence of Operations

1.02 ABBREVIATIONS AND DEFINITIONS:

- A. BACNET: Protocol for integration with BAS/BMS/EMS
- B. BAS / BMS / EMS: Building Automated System, Building Management System, Energy Management System
- C. D: Dimming Wall Switch
- D. FC: Footcandles. The metric for measuring light levels / illuminance levels
- E. GUI: Graphic User Interface
- F. LCP: Lighting Control Panel
- G. LonWorks: Protocol for integration with BAS/BMS/EMS
- H. OS/VS: Occupancy Sensor / Vacancy Sensor,
 - 1. Occupancy sensors provide automatic on and automatic shut-off.
 - 2. Vacancy sensors provide automatic shut-off only, and require manual-on.
- I. PC: Photocell
- J. RS: RS-232 Connection for AV Integration
- K. SC: Scene Control
- L. TC: Timeclock, or astronomical timeclock
- M. WS: Wall Switch
- N. WS/O: Wallbox Occupancy Sensor Switch
 - 1. Wall Switch with integrated Occupancy Sensor

1.03 REFERENCE STANDARDS

- A. UL 924 - Emergency Lighting and Power Equipment.

1.04 SYSTEM DESCRIPTIONS

- A. General Controls Approach:
 - 1. Level 2 Interior spaces and exterior lighting tied to Networked Panelized Relay Control System centrally located in the building.
 - a. Corridors
 - b. Waiting room
 - c. Secure Entry
 - d. Stair Landing
 - 2. Interior enclosed spaces tied to stand-alone controls.
 - a. Single Occupancy Restrooms
 - b. Storage Spaces
 - c. Lactation
 - 3. Interior enclosed spaces tied to local room controllers.
 - a. Pre-School Rooms
 - b. Conference rooms
 - c. Offices
 - d. Work Room

- e. Admin
- B. Emergency Egress:
 1. Lights indicated as emergency to override to full output during power loss.
 2. Provide UL 924 devices for emergency lights such that during normal power conditions the lights function (switch, dim by WS, dim by photocell, etc.) with the rest of the lights in the associated zone, and such that during emergency power conditions the lights override to full output.
- C. Timeclock Scheduling Groups:
 1. Corridors
 2. Waiting Room

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SPACE-BY-SPACE SEQUENCE OF OPERATION

- A. Level 2 Corridors, and Waiting Room
 1. Automatic on/off by time clock.
 2. After hours operation
 - a. Automatic on/off by occupancy sensor
 - b. Upon sensed occupant by any sensor within circulation area, all luminaires within the associated areas are to come on at full brightness.
 - 1) Time Delay:
 - (a) 15 minutes
- B. Level 2 Child Restroom
 1. Automatic on/off by occupancy sensor.
 2. Time Delay:
 - a. 20 minutes.
- C. Level 2 Offices, Conference Rooms, Pre-School Rooms, Teacher Work Room
 1. Manual on/ automatic off by vacancy sensor
 - a. Time Delay:
 - 1) 20 minutes
 - b. Local switch for manual override
- D. Level 2 Storage Spaces, Lactation, Break Room
 1. Manual on/ automatic off by occupancy sensor or wall box occupancy sensor switch
 2. Time Delay
 - a. 5 minutes
- E. Exterior Landing
 1. Automatic on/off by timeclock
- F. Other Spaces:
 1. Sequence of operations will be provided upon written request for all spaces not listed. Reprogramming may be required of some spaces on site after installation to tune the system and meet the Owner, daylight and energy management needs. Provide additional programming for reconfiguration up to 24 hours at no additional cost to the Owner or design team.

END OF SECTION 26 0993

SECTION 26 2100
LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical service requirements.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Materials and installation requirements for cast-in-place concrete equipment pads.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

1.03 DEFINITIONS

- A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.04 REFERENCE STANDARDS

- A. IEEE C2 - National Electrical Safety Code.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NFPA 70 - National Electrical Code.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. No later than two weeks following date of the Agreement, notify Utility Company of anticipated date of service.
- B. Coordination:
 - 1. Verify the following with Utility Company representative:
 - a. Utility Company requirements, including division of responsibility.
 - b. Exact location and details of utility point of connection.
 - c. Utility easement requirements.
 - d. Utility Company charges associated with providing service.
 - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
 - 3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Coordinate the work with other installers to provide communication lines required for Utility Company meters.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.
- D. Utility Company charges associated with providing permanent service to be paid by Owner.
- E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.
- F. Scheduling:
 - 1. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.
 - 2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.06 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Utility Company letter of availability for providing electrical service to project.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.
- D. Shop Drawings: Include dimensioned plan views and sections indicating locations and arrangement of Utility Company and service entrance equipment, metering provisions, required clearances, and proposed service routing.
 - 1. Obtain Utility company approval of shop drawings prior to submittal.
- E. Drawings prepared by Utility Company.
- F. Project Record Documents: Record actual locations of equipment and installed service routing.

1.07 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. IEEE C2 (National Electrical Safety Code).
 - 2. NFPA 70 (National Electrical Code).
 - 3. The requirements of the Utility Company.
 - 4. The requirements of the local authorities having jurisdiction.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
- B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 ELECTRICAL SERVICE REQUIREMENTS

- A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.
- B. Electrical Service Characteristics: As indicated on drawings.
- C. Utility Company: As indicated on drawings.
- D. Division of Responsibility: As indicated on drawings.
- E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Verify and mark locations of existing underground utilities.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions and Utility Company requirements.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances and required maintenance access.
- D. Provide required trenching and backfilling in accordance with Section 31 2316.13.
- E. Construct cast-in-place concrete pads for utility equipment in accordance with Utility Company requirements and Section 03 3000.
- F. Provide required protective bollards in accordance with Utility Company requirements.
- G. Provide required support and attachment components in accordance with Section 26 0529.
- H. Provide grounding and bonding for service entrance equipment in accordance with Section 26 0526.
- I. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 0553.

3.04 PROTECTION

- A. Protect installed equipment from subsequent construction operations.

END OF SECTION 26 2100

SECTION 26 2413 SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.
- B. Overcurrent protective devices for switchboards.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 0573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- F. Section 26 2100 - Low-Voltage Electrical Service Entrance.
 - 1. Includes Utility Company contact information.
- G. Section 26 27 13 - Electricity Metering.
- H. Section 26 2813 - Fuses: Fuses for fusible switches.
 - 1. Includes requirements for spare fuses and spare fuse cabinets.
- I. Section 26 4300 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA 400 - Standard for Installing and Maintaining Switchboards.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- G. NEMA PB 2 - Deadfront Distribution Switchboards.
- H. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
- I. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- J. NFPA 70 - National Electrical Code.
- K. UL 98 - Enclosed and Dead-Front Switches.
- L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- M. UL 869A - Reference Standard for Service Equipment.
- N. UL 891 - Switchboards.
- O. UL 977 - Fused Power-Circuit Devices.
- P. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Service Entrance Switchboards:
1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.
 2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
 3. See Section 26 2100 for Utility Company contact information and additional requirements.
 4. Obtain Utility Company approval of switchboard prior to fabrication.
 5. Preinstallation Meeting: Convene one week prior to commencing work of this section to review requirements with Utility Company representative.
 6. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
 2. Include wiring diagrams showing all factory and field connections.
 3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 4. Include documentation of listed series ratings upon request.
 5. Include documentation demonstrating selective coordination upon request.
- D. Service Entrance Switchboards: Include documentation of Utility Company approval of switchboard.
- E. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 2 as production (routine) tests.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Field Quality Control Test Reports.
- H. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.
- I. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 6000 - Product Requirements, for additional provisions.

2. Enclosure Keys: Two of each different key.
3. Electronic Trip Circuit Breakers: Provide one portable test set.
4. Drawout Devices:
 - a. Handles Necessary for Racking of Devices: One for each electrical room containing switchgear with drawout devices.
 - b. Lifting Yokes: One of each different yoke required, for each electrical room containing drawout devices.
 - c. Portable Lifting Devices: One for each electrical room containing switchboards with drawout devices and no integral top rail-mounted lifting device.
 - d. Removable Covers: One for blocking each different opening size when device is temporarily removed from its compartment.
5. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.
- B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.
- C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Switchboards - Basis of Design: Eaton Corporation.
- B. Switchboards - Other Acceptable Manufacturers:
 1. General Electric Company.
 2. Schneider Electric; Square D Products.
 3. Siemens Industry, Inc.
- C. Substitutions: See Section 01 6000 - Product Requirements.
- D. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- E. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 SWITCHBOARDS

- A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.
- D. Front-Connected Switchboards:
 - 1. Main Device(s): Individually-mounted.
 - 2. Feeder Devices: Panel/group-mounted.
 - 3. Arrangement: Front accessible only (not rear accessible), rear aligned.
 - 4. Gutter Access: Bolted covers.
- E. Rear-Connected Switchboards:
 - 1. Main Device(s): Individually-mounted.
 - 2. Feeder Devices: Individually-mounted.
 - 3. Compartmentalization: Provide barriered compartments for each overcurrent protective device, distribution bus, and rear cable connection area.
 - 4. Arrangement: Rear accessible, front and rear aligned.
 - 5. Rear Access: Bolted covers.
- F. Service Entrance Switchboards:
 - 1. Listed and labeled as suitable for use as service equipment according to UL 869A.
 - 2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
 - 3. Comply with Utility Company requirements for electrical service.
 - 4. Utility Metering Provisions: Provide separate barriered compartment complying with Utility Company requirements where indicated or where required by Utility Company. Include hinged sealable door and provisions for Utility Company current transformers (CTs), potential transformers (PTs), or potential taps as required.
 - 5. See Section 26 2100 for additional requirements.
- G. Switchboards With Busway Transitions: Configured for bussed connection to busway provided in accordance with Section 26 2513.
- H. Service Conditions:
 - 1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
 - a. Altitude: Less than 6,600 feet.
 - b. Ambient Temperature:
 - 1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.
 - 2) Switchboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.
- I. Short Circuit Current Rating:
 - 1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.
 - 3. Minimum Rating: 65,000 rms symmetrical amperes.
 - 4. Listed series ratings are acceptable only where specifically indicated.

5. Label equipment utilizing series ratings as required by NFPA 70.
- J. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- K. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.
- L. Bussing: Sized in accordance with UL 891 temperature rise requirements.
 1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
 2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 4. Phase and Neutral Bus Material: Aluminum.
 5. Ground Bus Material: Aluminum.
- M. Conductor Terminations: Suitable for use with the conductors to be installed.
 1. Line Conductor Terminations:
 - a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - b. Main and Neutral Lug Type: Mechanical.
 2. Load Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - b. Lug Type:
 - 1) Provide mechanical lugs unless otherwise indicated.
 - 2) Provide compression lugs where indicated.
- N. Enclosures:
 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
 - b. Outdoor Locations: Type 3R.
 2. Finish: Manufacturer's standard unless otherwise indicated.
 3. Enclosure Space Heaters:
 - a. Provide in each switchboard section installed outdoors and in unconditioned indoor spaces.
 - b. Size according to manufacturer's recommendations for worst case ambient temperature to prevent condensation.
 - c. Heater Control: Thermostat.
 - d. Heater Power Source: Provide connection to transformer factory-installed in switchboard or suitable external branch circuit as indicated or as required.
 4. Outdoor Enclosures:
 - a. Enclosure Type: Non-walk-in type unless otherwise indicated.
 - b. Color: Manufacturer's standard.
 - c. Access Doors: Lockable, with all locks keyed alike.
 - d. Walk-in Enclosure Features:
 - 1) Personnel Doors: Open to exterior; equipped with panic hardware.
 - 2) Aisle lighting, with switch at each access door.
 - 3) GFCI duplex convenience receptacle.
- O. Future Provisions:
 1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.
 3. Where designated spaces for future device provisions are not indicated, include provisions for minimum of _____ device(s) rated at _____ percent of rating of switchboard main or incoming feed.
 4. Arrange and equip through bus and ground bus to accommodate future installation of additional switchboard sections.
- P. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 4300, list switchboards as a complete assembly including surge protective device.
- Q. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
 - a. Use zero sequence or residual ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
 - c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.
- R. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.
- S. Metering:
1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
 2. Metering type to be as indicated on Design Drawings.
 - a. See Section 26 27 13, for metering equipment requirements.
- T. Instrument Transformers:
1. Comply with IEEE C57.13.
 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 3. Current Transformers: Connect secondaries to shorting terminal blocks.
 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.03 OVERCURRENT PROTECTIVE DEVICES

- A. Fusible Devices:
1. Fusible Switches:
 - a. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
 - b. Fuse Clips: As required to accept indicated fuses.
 - 1) Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
 - c. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

2. Fused Power-Circuit Devices:
 - a. Description: Quick-make, quick-break, dead-front bolted-pressure contact switches and high-pressure butt contact switches listed and labeled as complying with UL 977; ratings, configurations, and features as indicated on the drawings.
 - b. Bolted-Pressure Contact Switches: Devices with additional pressure or clamping action provided at both ends of switch blades when blades are in the fully closed position.
 - c. High-Pressure Butt Contact Switches: Devices with butt-type contacts and spring-charged mechanism.
 - d. Minimum Short Circuit Current Rating: 200,000 rms symmetrical amperes when protected by Class L fuses.
 - e. Fuse Clips: As required to accept Class L fuses.
 - f. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
 - g. Provide the following features and accessories where indicated or where required to complete installation:
 - 1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - 2) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating switch position.
 - 3) Blown fuse protection and indication.
- B. Circuit Breakers:
 1. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
 2. Molded Case Circuit Breakers:
 - a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 1) Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 250 amperes.
 - 2) Provide electronic trip circuit breakers for circuit breaker frame sizes 250 amperes and above.
 - b. Minimum Interrupting Capacity:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 14,000 rms symmetrical amperes at 480 VAC.
 - c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - 2) Provide interchangeable trip units where indicated.

- d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1) Provide the following field-adjustable trip response settings:
 - (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - (b) Long time delay.
 - (c) Short time pickup and delay.
 - (d) Instantaneous pickup.
 - (e) Ground fault pickup and delay where ground fault protection is indicated.
 - 2) Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
 - 3) Provide communication capability where indicated: Compatible with system indicated.
- e. Circuit breakers that are 1200 amp and larger rated, or can be adjusted to be 1200 amp or larger rated: Provide with an energy reducing maintenance switch adjustment to meet the requirements of NEC 240.87.
- f. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.
- g. Circuit-breaker frame sizes 250 A and larger shall be 100% rated to continuously carry their full ampere capacity.
- h. Provide the following circuit breaker types where indicated:
 - 1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.
 - 2) Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
- i. Provide the following features and accessories where indicated or where required to complete installation:
 - 1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - 2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
 - 3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
 - 4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
 - 5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.
 - 6) Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 7) Communication Capability: Communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - 8) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

- 9) Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - 10) Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 11) Handle Clamp: Loose attachment, for holding circuit-breaker handles in on position.
3. Insulated Case Circuit Breakers:
- a. Description: Quick-make, quick-break, trip-free circuit breakers with two-step stored energy closing mechanism; standard 80 percent rated unless otherwise indicated; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.
 - b. Operation:
 - 1) Provide manually operated circuit breakers unless otherwise indicated.
 - 2) Provide electrically operated circuit breakers where indicated.
 - 3) Pad-Lock Provision: For preventing circuit breaker closing operation.
 - c. Construction:
 - 1) Provide fixed-mount circuit breakers unless otherwise indicated.
 - 2) Provide drawout circuit breakers where indicated.
 - d. Drawout Circuit Breakers:
 - 1) Allows withdrawal of circuit breaker into test and disconnected positions, with racking position indication (connected, test, disconnected, withdrawn).
 - 2) Provide safety interlock to prevent racking of circuit breaker while in the ON position.
 - 3) Pad-Lock Provision: For preventing circuit breaker drawout operation.
 - e. Minimum Interrupting Capacity:
 - 1) 42,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 65,000 rms symmetrical amperes at 480 VAC.
 - f. Trip Units: Solid state, microprocessor-based, true rms sensing.
 - 1) Provide the following field-adjustable trip response settings:
 - (a) Long time pickup, adjustable by setting dial.
 - (b) Long time delay.
 - (c) Short time pickup and delay.
 - (d) Instantaneous pickup.
 - (e) Ground fault pickup and delay where ground fault protection is indicated.
 - 2) Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
 - 3) Provide communication capability where indicated: Compatible with system indicated.
 - g. Circuit breakers that are 1200 amp and larger rated, or can be adjusted to be 1200 amp or larger rated: Provide with an energy reducing maintenance switch adjustment to meet the requirements of NEC 240.87.
 - h. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

- i. Circuit-breaker frame sizes 250 A and larger shall be 100% rated to continuously carry their full ampere capacity.
- j. Provide the following circuit breaker types where indicated:
 - 1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.
 - 2) Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
- k. Provide the following features and accessories where indicated or where required to complete installation:
 - 1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - 2) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
 - 3) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
 - 4) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.
 - 5) Truck-Operated Cell Switch: For indicating circuit breaker racking position.
 - 6) Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 7) Communication Capability: Communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - 8) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - 9) Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - 10) Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 11) Handle Clamp: Loose attachment, for holding circuit-breaker handles in on position.

2.04 SOURCE QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:
 - 1. Dielectric tests.
 - 2. Mechanical operation tests.
 - 3. Grounding of instrument transformer cases test.
 - 4. Electrical operation and control wiring tests, including polarity and sequence tests.
 - 5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements are as indicated.
- B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.
- C. Verify mounting surfaces are ready to receive switchboards.
- D. Verify conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.
- C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.
- D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.
- E. Provide required support and attachment in accordance with Section 26 0529.
- F. Install switchboards plumb and level.
- G. Unless otherwise indicated, mount switchboards on properly sized 3.5 inch high concrete pad constructed in accordance with Section 03 3000. Pad should extend nominally 2-inches beyond edges of the equipment.
- H. Provide grounding and bonding in accordance with Section 26 0526.
- I. Install all field-installed devices, components, and accessories.
- J. Provide fuses complying with Section 26 2813 for fusible switches as indicated.
- K. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 0573.
- M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- N. Provide filler plates to cover unused spaces in switchboards.
- O. Identify switchboards in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.
- C. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- D. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.
- E. Inspect and test in accordance with NETA ATS, except Section 4.
- F. Perform inspections and tests listed in NETA ATS, Section 7.1.
- G. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- H. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than _____ amperes. Tests listed as optional are not required.
 - 1. Perform insulation-resistance tests on all control wiring with respect to ground.
 - 2. Test functions of the trip unit by means of secondary injection.
- I. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
 - 1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.
- J. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.
- K. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.
- L. Test shunt trips to verify proper operation.

- M. Correct deficiencies and replace damaged or defective switchboards or associated components.
- N. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of switchboard covers and doors.

3.05 CLEANING

- A. See Section 01 7419 - Construction Waste Management and Disposal, for additional requirements.
- B. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.
- C. Repair scratched or marred surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Training: Train Owner's personnel on operation, adjustment, and maintenance of switchboard and associated devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.

3.07 PROTECTION

- A. Protect installed switchboards from subsequent construction operations.

END OF SECTION 26 2413

SECTION 26 2416 PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 0573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- F. Section 26 2713 - Electricity Metering: For interface with equipment specified in this section.
- G. Section 26 2813 - Fuses: Fuses for fusible switches and spare fuse cabinets.
- H. Section 26 4300 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- F. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- G. NEMA PB 1 - Panelboards.
- H. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- I. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- J. NFPA 70 - National Electrical Code.
- K. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- L. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- M. UL 67 - Panelboards.
- N. UL 98 - Enclosed and Dead-Front Switches.
- O. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- P. UL 869A - Reference Standard for Service Equipment.
- Q. UL 943 - Ground-Fault Circuit-Interrupters.
- R. UL 1053 - Ground-Fault Sensing and Relaying Equipment.
- S. UL 1699 - Arc-Fault Circuit-Interrupters.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
 2. Include wiring diagrams showing all factory and field connections.
 3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 4. Include documentation of listed series ratings upon request.
- D. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.
- E. Field Quality Control Test Reports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 6000 - Product Requirements, for additional provisions.
 2. Panelboard Keys: Two of each different key.
 3. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
 - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
 - 2. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation
- B. General Electric Company
- C. Schneider Electric; Square D Products
- D. Siemens Industry, Inc
- E. Substitutions: See Section 01 6000 - Product Requirements.
- F. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
 - b. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.
 - 3. Listed series ratings are acceptable only where specifically indicated.
 - 4. Label equipment utilizing series ratings as required by NFPA 70.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 2. Provide 200 percent rated neutral bus and lugs where indicated, where oversized neutral conductors are provided, or where panelboards are fed from K-rated transformers.
 3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 4. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
 - c. Provide removable end walls for NEMA Type 1 enclosures.
 - d. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 4300, list and label panelboards as a complete assembly including surge protective device.
- L. Panelboard Contactors: Where panelboard contactors are indicated, provide electrically operated, mechanically held magnetic contactor complying with NEMA ICS 2.
1. Ampere Rating: Not less than ampere rating of panelboard bus.
 2. Short Circuit Current Rating: Not less than the panelboard short circuit current rating.
 3. Coil Voltage: As required for connection to control system indicated.
- M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
 - a. Use zero sequence ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
 - c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.

- N. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- O. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.
- P. Load centers are not acceptable.
- Q. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Feed-through lugs.
 - 2. Sub-feed lugs.
- R. Metering:
 - 1. Where indicated on Design Drawings, provide microprocessor-based digital electrical metering system including instrument transformers, wiring, and connections necessary for measurements specified.
 - 2. Metering type to be as indicated on Design Drawings
 - a. See Section 26 27 13 for metering equipment requirements.

2.03 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Products:
 - 1. Substitutions: See Section 01 6000 - Product Requirements.
- C. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- D. Bussing:
 - 1. Phase and Neutral Bus Material: Aluminum.
 - 2. Ground Bus Material: Aluminum.
- E. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
 - 2. Provide thermal magnetic circuit breakers unless otherwise indicated.
 - 3. Provide electronic trip circuit breakers where indicated.
- F. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.
- G. Circuit-breaker frame sizes 250 A and larger shall be 100 percent rated to continuously carry their full ampere capacity.
- H. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
 - 2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.
 - 3. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 4. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 5. Provide clear plastic circuit directory holder mounted on inside of door.

- I. Metering:
 - 1. Where indicated on Design Drawings, provide microprocessor-based digital electrical metering system including instrument transformers, wiring, and connections necessary for measurements specified.
 - 2. Metering type to be as indicated on Design Drawings
 - a. See Section 26 2713 for metering equipment requirements.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Products:
 - 1. Substitutions: See Section 01 6000 - Product Requirements.
- C. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- D. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Phase and Neutral Bus Material: Aluminum.
 - 3. Ground Bus Material: Aluminum.
- E. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- F. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 - 2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 4. Provide clear plastic circuit directory holder mounted on inside of door.
- G. Provide column-width panelboards with accessory column-width cable trough and pullbox where indicated.
- H. Metering:
 - 1. Where indicated on Design Drawings, provide microprocessor-based digital electrical metering system including instrument transformers, wiring, and connections necessary for measurements specified.
 - 2. Metering type to be as indicated on Design Drawings
 - a. See Section 26 2713 for metering equipment requirements.

2.05 OVERCURRENT PROTECTIVE DEVICES

- A. Fusible Switches:
 - 1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
 - 2. Fuse Clips: As required to accept indicated fuses.
 - a. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
4. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Provide compression lugs where indicated.
 - c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- B. Molded Case Circuit Breakers:
 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 14,000 rms symmetrical amperes at 480 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated. Acceptable only where specifically indicated.
 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Provide compression lugs where indicated.
 - c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - b. Provide interchangeable trip units where indicated.
 5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - 2) Long time delay.
 - 3) Short time pickup and delay.
 - 4) Instantaneous pickup.
 - 5) Ground fault pickup and delay where ground fault protection is indicated.
 - b. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
 - c. Provide communication capability where indicated: Compatible with system indicated.
 6. Provide 100 percent Rated Circuit Breakers for circuit breaker frame sizes 250 amperes and larger.
 7. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
 8. Provide the following circuit breaker types where indicated:

- a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 - b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
 - c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
 - d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
 - e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
9. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
10. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
11. Do not use tandem circuit breakers.
12. Do not use handle ties in lieu of multi-pole circuit breakers.
13. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
14. Provide the following features and accessories where indicated or where required to complete installation:
- a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.
 - c. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
 - d. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
 - e. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.06 SOURCE QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements are as indicated.
- B. Verify the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 26 0529.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
- J. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- K. Provide grounding and bonding in accordance with Section 26 0526.
 - 1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
 - 2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.
- L. Install field-installed branch devices, components, and accessories.
- M. Provide fuses complying with Section 26 2813 for fusible switches as indicated.
- N. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- O. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- P. Set field-adjustable circuit breaker tripping function settings as indicated.
- Q. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 0573.
- R. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- S. Provide filler plates to cover unused spaces in panelboards.
- T. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Emergency and night lighting circuits.
 - 2. Fire detection and alarm circuits.
 - 3. Communications equipment circuits.
 - 4. Intrusion detection and access control system circuits.
 - 5. Video surveillance system circuits.
- U. Identify panelboards in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than _____ amperes. Tests listed as optional are not required.
 - 1. Perform insulation-resistance tests on all control wiring with respect to ground.
 - 2. Test functions of the trip unit by means of secondary injection.
- E. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
 - 1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

- F. Test GFCI circuit breakers to verify proper operation.
- G. Test AFCI circuit breakers to verify proper operation.
- H. Test shunt trips to verify proper operation.
- I. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.
- J. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 2416

**SECTION 26 2713
ELECTRICITY METERING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment for Owner Electricity Metering.
- B. Basic Electricity Metering:
 - 1. Single circuit electricity meters.
 - 2. Multi-circuit electricity meters.
 - 3. Branch circuit electricity meter (BCEM).
- C. Advanced Electricity Metering:
 - 1. Single circuit meter.
 - 2. Multi-circuit meter.
- D. Power Quality Electricity Metering:
 - 1. Single circuit meter.
- E. Ethernet Gateway for Electricity Meters.
- F. Data Acquisition Servers.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0533.16 - Boxes for Electrical Systems: Cabinets and enclosures for metering system components.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 13 13 - Metal-Clad Switchgear.
- F. Section 26 2413 - Switchboards: For interface with meters specified in this section.
- G. Section 26 2416 - Panelboards: For interface with meters specified in this section.
- H. Section 26 2813 - Fuses.
 - 1. Includes requirements for spare fuses and spare fuse cabinets.

1.03 REFERENCE STANDARDS

- A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- E. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work to provide equipment suitable for interface with electricity metering systems to be provided.
 - 2. Coordinate the work with other installers to provide communication lines required for electricity metering system interface.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Preinstallation Meeting: Conduct meeting with facility representative and other related equipment manufacturers to discuss electricity metering system interface requirements.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Product Data:
 - 1. Provide manufacturer's standard catalog pages and data sheets for electricity metering systems and associated components and accessories.
 - 2. Include ratings, configurations, standard wiring diagrams, dimensions, service condition requirements, and installed features.
 - 3. Include manufacturer's published data tables with complete listing of metering device Modbus registers and/or BacNet Object IDs with associated data descriptions, formats, units, scale factors.
- C. Shop Drawings:
 - 1. Include system interconnection schematic diagrams showing all factory and field connections. Diagrams to include potential transformer (PT) and current transformer (CT) connections that clearly indicate the point(s) of metering device sensing within the electrical distribution system to be metered and indicate the CT orientation (polarity) with respect to the metered circuit.
 - 2. Include requirements for interface with other systems.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Field Quality Control Test Reports.
- F. Project Record Documents:
 - 1. Final as built system interconnection schematic diagrams.
 - 2. Final equipment settings:
 - a. Device usernames and passwords updated from factory defaults.
 - b. TCP/IPv4 network settings for all Ethernet enabled meters configured for Modbus/TCP or BacNet/TCP
 - c. TCP/IPv4 network settings for all Ethernet enabled electrical metering equipment gateways and/or protocol converters.
 - d. Modbus slave IDs for all RS485 enabled meters.
 - e. Meter device configuration reports.
 - f. Meter device setting file exports.
- G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Enclosure Keys: Two of each different key.
 - 3. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
- B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Electricity Meters - Basis of Design: Veris Industries E51C2.
- B. Other Acceptable Manufacturers:
 - 1. Leviton
 - 2. Same as manufacturer of electrical distribution equipment used for this project.
- C. Substitutions: See Section 01 6000 - Product Requirements.
- D. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- E. Source Limitations: Furnish electricity meters produced by a single manufacturer and obtained from a single supplier.

2.02 EQUIPMENT FOR OWNER ELECTRICITY METERING

- A. Provide microprocessor-based digital electricity metering systems including instrument transformers, wiring, and connections necessary for measurements specified.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Provide electricity metering systems and associated components compatible with the equipment and associated circuits to be metered.
- D. Service Conditions: Provide electricity meters suitable for operation under the service conditions at the installed location.
 - 1. Altitude: _____ feet.
 - 2. Ambient Temperature: Between _____ degrees F and _____ degrees F.
- E. Meters
 - 1. Designed for multifunction electrical measurement on 3 phase power systems. Meter to perform to spec in harsh electrical applications in high and low voltage power systems.
 - 2. Support 3 element Wye, 2.5 element Wye, 2 element Delta, 4 wire Delta systems.
 - 3. Surge Withstand: conform to IEEE C37.90.1
 - 4. Fault Current Withstand: 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.
 - 5. Inputs and outputs: galvanically isolated to 2500 VAC.
- F. Enclosures:
 - 1. Where not furnished by manufacturer, provide required cabinets and enclosures in accordance with Section 26 0533.16 - Boxes for Electrical Systems.
 - 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R or Type 4.
 - 3. Provide lockable door(s) for outdoor locations.
 - 4. Finish: Manufacturer's standard unless otherwise indicated.
- G. Instrument Transformers:
 - 1. Comply with IEEE C57.13, where applicable.

2. Select suitable ratio, burden, and accuracy as required for connected devices, including protective relay equipment that may be present in the design.
 3. Select suitable insulation/voltage class for the circuit to be metered.
 4. Current Transformers:
 - a. Solid Core CTs for less than or equal to 400A primary metering applications unless otherwise noted in Design.
 - b. Split Core CTs for 600A and greater primary metering applications unless otherwise noted in Design.
 - c. Rogowski CTs permitted only with pre-bid approval or as indicated in the Design.
 - d. Compatible with connected meters; replace meters damaged by connection of incompatible current transformers.
 - e. Provide shorting terminal blocks for connection of secondaries where applicable.
 - f. CT line voltage terminals to be finger safe.
 5. Potential Transformers:
 - a. Include primary and secondary fuses with disconnecting means.
 - b. CT line voltage terminals to be finger safe.
- H. Interface with Other Work:

2.03 BASIC ELECTRICITY METERS

- A. Electricity meters with "M|B" annotations as indicated on Design Documents are subject to the requirements of this Part. Basic electricity meters can be Single Circuit, Multi-Circuit or Branch Circuit type electricity meters as indicated on Design Documents.
- B. Basic Electricity Meter equipment to be connected to Facility Building Management System (BMS)
 1. Basic meters to communicate with Facility BMS via BACnet-IP communication protocol.
 2. See Section 23 0913 - Instrumentation and Control Devices for HVAC.
 3. See Design Documentation for additional requirements.
- C. Basic Electricity Meter equipment to be provided with Data Acquisition Servers (DAS)
 1. Basic meters to communicate with DAS via BACnet-IP communication protocol.
 2. DAS equipment, if provided, to be dedicated to Division 26 electricity meter data acquisition, storage, display and retrieval.
 3. DAS to be capable of logging hourly interval data from meters and retaining logged data in non-volatile memory for a minimum of 36 months.
 4. See Design Documentation for additional requirements
- D. Single Circuit Electricity Meter
 1. Basis of Design:
 - a. Electro Industries Shark 50B
 2. Display:
 - a. Integral LED to present user scrollable display of measured readings.
 3. Enclosure:
 - a. Integrated into switchgear or switchboard assembly or into dedicated cabinet. If switchgear/switchboard integrated, the metering section or cubicle will include dielectric barriers to separate the meter equipment space from live electrical components, shock hazards and Arc Flash hazards.
 - b. Include terminal blocks, fuses, power supplies and other accessories as required to satisfy the Design.
- E. Multi-Circuit Electricity Meter
 1. Basis of Design:
 - a. Electro Industries Shark MP200
 2. Number of metering points:

- a. Capable of metering 8 or more three phase circuits via a single multi-point meter assembly and associated enclosure.
 - b. Capable of metering 24 or more single phase circuits via a single multi-point meter assembly and associated enclosure.
 - 3. Display:
 - a. Optional integral or remote color LED touch screen display to display real time data for each metered point.
 - b. See Design Documents for inclusion and desired location.
 - 4. Enclosure:
 - a. Integrate into switchgear or switchboard assembly or into dedicated cabinet. If switchgear/switchboard integrated, the metering section or cubicle will include dielectric barriers to separate the meter equipment space from live electrical components, shock hazards and Arc Flash hazards.
 - b. Include terminal blocks, fuses, power supplies and other accessories as required to satisfy the Design.
- F. Branch Circuit Electricity Meter (BCEM)
 - 1. Basis of Design:
 - a. Schneider Electric PowerLogic Branch Circuit Power Meter (BCPM)
 - b. Eaton Power Xpert Branch Circuit Monitor (PXBCM)
 - 2. As indicated in Design Documents or as required for panelboard branch circuits to be monitored. Product to have configurations available for monitoring up to 84 branch circuits, two 3-phase main devices, and two neutrals with a single meter.
 - 3. Each branch circuit and main device metering point to be subject to the product and functional requirements of this Part (Basic Electricity Meters).
 - 4. Display:
 - a. Optional integral or remote color LED touch screen display to display real time data for each metered point.
 - b. See Design Documents for inclusion and desired location.
- G. Basic Electricity Metering Product Requirements:
 - 1. Accuracy:
 - a. Real Power/Energy: Plus/minus 0.5 percent, complying with ANSI C12.20 accuracy and IEC 62053-21, Class 0.5, or IEC 60253-22, Class 0.5S.
 - b. Reactive Power/Energy: Plus/minus 1.0 percent, complying with IEC 62053-24, Class 1, or better.
 - c. Line to Neutral Voltage: Plus/minus 0.2 percent.
 - d. Line to Line Voltage: Plus/minus 0.4 percent.
 - e. Current: Plus/minus 0.2 percent.
 - f. Power Factor: Plus/minus 1.0 percent.
 - g. Frequency: Plus/minus 0.01 Hz.
 - 2. Sampling Frequency, Update Rate and Harmonics:
 - a. Sampling frequency: 400 per cycle (24,000Hz)
 - b. Update rate: 2 seconds (maximum)
 - c. Harmonics Resolution: N/A.
 - 3. Measured Parameters:
 - a. Real energy (kWh); per phase and total of phases.
 - b. Reactive energy (kVARh); per phase and total of phases.
 - c. Apparent energy (kVAh); per phase and total of phases.
 - d. Real power (kW); Average and maximum over a user-specified interval of one hour or less.

- e. Reactive power (kVAR); Average and maximum over a user-specified interval of one hour or less.
- f. Apparent power (kVA); Average and maximum over a user-specified interval of one hour or less.
- g. Bi-directional Energy Measurements:
 - 1) Real/active energy (kWh) and apparent energy (kVAh); imported (from the grid), exported (to the grid), and signed net total.
 - 2) Reactive energy (kVARh); imported (from the grid) and exported (to the grid), per quadrant as defined by IEEE 1459.
 - 3) Maximum demand; real/active power (kW), reactive power (kVAR), and apparent power (kVA); imported (from the grid) and exported (to the grid).
- h. Current; per phase and average of phases.
- i. Voltage; line-to-line and line-to-neutral; per phase and average of phases.
- j. Power factor; per phase and average of phases.
- k. Frequency.
- 4. Non-Volatile Memory:
 - a. N/A
- 5. Data Logging
 - a. N/A
- 6. Waveform Recording
 - a. N/A
- 7. Alarm
 - a. N/A
- 8. Meter Inputs/Outputs (I/O):
 - a. NA
- 9. Communications:
 - a. Compatible with connected systems. Provide accessories necessary for proper interface.
 - b. Protocol converters not permitted unless otherwise noted in Design Documentation or this Section.
 - c. Serial Communications (at least one of the following):
 - 1) RS-485, 2-wire; support for Modbus RTU
 - 2) RS-485, 2-wire; support for BACnet MS/TP
 - d. Ethernet Communications (at least one of the following):
 - 1) Modbus TCP/IP
 - 2) BacNet IP

2.04 ADVANCED ELECTRICITY METERS

- A. Electricity meters with “M|A” annotation as indicated on Design documents are subject to the requirements of this Part.
- B. Advanced Electricity Meter equipment to be connected to Facility Building Management System (BMS)
 - 1. Basic meters to communicate with Facility BMS via BACnet-IP communication protocol.
 - 2. See Section 23 0913 - Instrumentation and Control Devices for HVAC.
 - 3. See Design Documentation for additional requirements.
- C. Advanced Electricity Meter equipment to be provided with Data Acquisition Servers (DAS)
 - 1. Basic meters to communicate with DAS via BACnet-IP communication protocol.
 - 2. DAS equipment, if provided, to be dedicated to Division 26 electricity meter data acquisition, storage, display and retrieval.

3. DAS to be capable of logging hourly interval data from all meters and retaining logged data in non-volatile memory for a minimum of 36 months.
 4. See Design Documentation for additional requirements
- D. Single Circuit Electricity Meter
1. Basis of Design:
 - a. Electro Industries Shark 200v5
 2. Display
 - a. Integral LED to present user scrollable display of measured readings.
 3. Enclosure
 - a. Integrate into switchgear or switchboard assembly or into dedicated cabinet. If switchgear/switchboard integrated, the metering section or cubicle will include dielectric barriers to separate the meter equipment space from live electrical components, shock hazards and Arc Flash hazards.
 - b. Inclusive of terminal blocks, fuses, power supplies and other accessories as required to satisfy the Design.
- E. Advanced Electricity Metering Product Requirements:
1. Accuracy:
 - a. Real Power/Energy: Plus/minus 0.2 percent, complying with ANSI C12.20 accuracy and IEC 62053-22, Class 0.2S.
 - b. Reactive Power/Energy: Plus/minus 1.0 percent, complying with IEC 62053-24, Class 1 or better.
 - c. Line to Neutral Voltage: Plus/minus 0.1 percent.
 - d. Line to Line Voltage: Plus/minus 0.2 percent.
 - e. Current: Plus/minus 0.2 percent.
 - f. Power Factor: Plus/minus 0.2 percent.
 - g. Frequency: Plus/minus 0.01 Hz.
 2. Sampling Frequency, Update Rate and Harmonics
 - a. Sampling frequency: 400 per cycle (24,000 Hz)
 - b. Update rate: Watts, VARs and VA at 0.1 seconds (6 cycles) and other recorded parameters at 1.0 seconds (60 cycles).
 - c. Harmonics Resolution: 40x of fundamental frequency (40th Order).
 3. Measured Parameters:
 - a. Real energy (kWh); per phase and total of phases.
 - b. Reactive energy (kVARh); per phase and total of phases.
 - c. Apparent energy (kVAh); per phase and total of phases.
 - d. Real power (kW); Average and maximum over a user-specified interval of one hour or less
 - e. Reactive power (kVAR); Average and maximum over a user-specified interval of one hour or less
 - f. Apparent power (kVA); Average and maximum over a user-specified interval of one hour or less
 - g. Bi-directional Energy Measurements:
 - 1) Real/active energy (kWh) and apparent energy (kVAh); imported (from the grid), exported (to the grid), and signed net total.
 - 2) Reactive energy (kVARh); imported (from the grid) and exported (to the grid), per quadrant as defined by IEEE 1459.
 - 3) Maximum demand; real/active power (kW), reactive power (kVAR), and apparent power (kVA); imported (from the grid) and exported (to the grid).
 - h. Current; per phase and average of phases.
 - i. Voltage; line-to-line and line-to-neutral; per phase and average of phases.

- j. Power factor; per phase and average of phases.
- k. Frequency.
- 4. Non-Volatile Memory
 - a. Minimum 3 megabytes.
- 5. Data Logging
 - a. Real-time clock that allows for time stamping of logged data.
 - 1) Equipped with seven (7) dedicated log files as follows:
 - (a) Three (3) historical logs for trending profiles. Each log programmable with up to sixty-four (64) parameters. User allocatable memory between each of the historical logs in order to increase or decrease the memory allotted to each of the logs.
 - (b) One (1) log for Limits Alarms. Limits log provides magnitude and duration of an event, time-stamp, and log value. Log capable of recording to 2048 events.
 - (c) One (1) log for System Events. System Events log records the following occurrences with a time-stamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, Programmable Settings Changes, and Critical Data Repairs.
 - (d) One (1) log for I/O changes. I/O Change log provides a time-stamped record of any Relay Outputs and any Input Status changes. The log must be capable of recording up to 2048 events.
 - (e) One (1) log for Waveform Recording
- 6. Waveform Recording:
 - a. Triggering:
 - 1) Up to 16 user settable waveform capture triggers based on percent of full-scale for measured parameters.
 - 2) Voltage and current trigger setpoints compared against RMS measured values updated on a 1-cycle basis.
 - b. Event Capture:
 - 1) User programmable sampling rates of 16, 32 or 64 samples per cycle for waveform capture.
 - 2) Pre-event and post-event recording.
 - 3) Meter stores waveform capture events on a first-in, first-out basis to ensure most recent waveform capture data is continuously recorded.
 - 4) Integral non-volatile memory available for waveform capture storage.
- 7. Limit Alarms
 - a. User configurable limit alarm setpoints for measured parameters.
 - b. Setpoints to be based on percentage of full scale for measured parameters.
 - c. Up to 16 limit alarm setpoints.
 - d. User configurable limit alarms to map to meter I/O (if equipped).
 - e. User configurable limit alarms to map to remote annunciation (if equipped).
- 8. Meter Inputs/Outputs (I/O):
 - a. I/O expandability through two (2) option card slots on the back.
 - b. I/O cards capable of being installed in the field, without removing the meter from installation.
 - c. Meter auto-detects the presence of any I/O option cards.
 - d. Meter capable of accepting any combination of I/O option cards.
 - e. Option card slots accept I/O cards in all of the following formats:
 - 1) 100BaseT Ethernet Communication Card
 - 2) Four Channel Bi-directional 0-1mA Output Card
 - 3) Four Channel 4-20mA Output Card

- 4) Two Relay Outputs/2 Status Inputs Card
 - 5) Four Pulse Output/4 Status Inputs Card
 - 6) Fiber Optic Card
 - 7) IEC 61850 Protocol Ethernet Network Card.
9. Communications:
- a. Compatible with connected systems. Provide accessories necessary for proper interface.
 - b. Protocol converters not permitted unless otherwise noted in Design Documentation or this Section.
 - c. Serial Communications:
 - 1) RS-485, 2-wire via fixed backplate terminals.
 - 2) Baud rate to be user configurable from 1,200 to 57,600.
 - 3) Support for serial protocols:
 - (a) Modbus ASCII.
 - (b) Modbus RTU.
 - (c) DNP3.
 - (d) BACNet MS/TP via Electro Industries ProtoCom-KT Gateway.
 - d. Programming Port:
 - 1) Dedicated optical Infrared Data Association (IrDA) type programming port located on meter faceplate.
 - 2) Allow the unit to be set up and programmed using a remote laptop without need for a communication cable.
 - 3) Provide (2) USB to IrDA adapter cables for facility owner O&M operations.
 - e. Ethernet Communications:
 - 1) Provided pre-installed at factory unless otherwise noted on Design Drawings.
 - 2) 100BaseT Ethernet.
 - 3) NTP time server for high accuracy network time synchronization.
 - 4) Allow the meter to speak with 12 simultaneous sockets of Modbus TCP, so that multiple requests for data can be received simultaneously.
 - 5) Allow the meter to speak with 5 simultaneous sockets of DNP over TCP/IP so that multiple requests can be handled simultaneously, using standard and optional ports.
 - 6) Allow the meter to speak with both Modbus TCP and DNP over Ethernet simultaneously.
 - 7) Allow auto transmit/receive detection for straight or null RJ45 cables.
 - 8) Provide an embedded Web server that allows access to metered readings through the Internet, using any standard Web browser from a PC, smart phone, or tablet PC.
 - 9) Provide email on configured alarms.
 - 10) Provide email notification of meter status and readings data on a programmed schedule.
- F. DAS equipment, if provided, to be dedicated to Division 26 electricity meter data acquisition, storage, display and retrieval.
- 1) Provide data push of up to 15 meter readings to a cloud server with the JSON structure.
 - 2) Provide heightened security by allowing setup of an exclusive TCP/IP client. When the client is communicating through the meter's network card, no other communication to that network card will be allowed, to protect against unauthorized programming.

- 3) The meter shall be programmable to shut down unused network services to protect against meter tampering.
 - 4) BacNet IP via Electro Industries ProtoCom-KT Gateway
 - 5) When two Ethernet cards are installed in the meter, an independent IP address and MAC address shall be assignable to each card.
- b. Relay Output & Status Input:
- 1) Optional I/O Card – Provide only when indicated on Design Documents or required in other specification Sections.
- c. IEC 61850:
- 1) Optional I/O card – Provide only when indicated on Design Documents or required in other specification Sections.
 - 2) Integrates into any IEC 61850 network.
 - 3) Provides support for Modbus and IEC 61850 protocols simultaneously.
 - 4) Configurable for multiple logical nodes.
 - 5) Provides buffered and unbuffered reporting.
 - 6) Certified by a 3rd party Authorized IEC61850 Test Laboratory.
 - 7) Capable of supporting two Ethernet /IP connections with separate /IP addresses, each running IEC 61850 protocol.
 - 8) Provide heightened security using setup of an exclusive TCP/IP client. When the client is communicating through the meter's network card, no other communication to that network card permitted, to protect against unauthorized programming.

2.05 POWER QUALITY (PQ) ELECTRICITY METERS

- A. Electricity meters with “M|Q” annotation as indicated on Design documents are subject to the requirements of this Part.
- B. PQ Meter equipment to be connected to Facility Building Management System (BMS):
1. Basic meters to communicate with Facility BMS via BACnet-IP communication protocol.
 2. See Section 23 0913 - Instrumentation and Control Devices for HVAC.
 3. See Design Documentation for additional requirements.
- C. PQ Meter equipment to be provided with Data Acquisition Servers (DAS):
1. Basic meters to communicate with DAS via BACnet-IP communication protocol.
 2. DAS to be capable of logging hourly interval data from all meters and retaining logged data in non-volatile memory for a minimum of 36 months.
 3. See Design Documentation for additional requirements.
- D. Single Circuit Electricity Meter.
1. Basis of Design:
 - a. New Construction:
 - 1) Electro Industries Nexus 1500v3.
 - b. Retrofit:
 - 1) Electro Industries Nexus 1450v2.
 2. Display:
 - a. New construction:
 - 1) Integral LED to present user scrollable display of measured readings.
 - 2) Supports screen rotation to enable vertical meter mounting.
 - b. Retrofit:
 - 1) Remote color LED touch screen display to display real time data for each metered point.
 3. Enclosure:

- a. Integrate into switchgear or switchboard assembly or into dedicated cabinet. If switchgear/switchboard integrated, the metering section or cubicle will include dielectric barriers to separate the meter equipment space from live electrical components, shock hazards and Arc Flash hazards.
 - b. Inclusive of terminal blocks, fuses, power supplies and other accessories as required to satisfy the Design.
- E. Power Quality Electricity Metering Product Requirements:
1. Accuracy:
 - a. Real Power/Energy: Plus/minus 0.2 percent, complying with ANSI C12.20 accuracy and IEC 62053-22, Class 0.2S.
 - b. Reactive Power/Energy: Plus/minus 1.0 percent, complying with IEC 62053-24, Class 1 or better.
 - c. Line to Neutral Voltage: Plus/minus 0.05 percent.
 - 1) 0.05 percent for the one second reading (High Accuracy).
 - 2) 0.1 percent for the 100-millisecond reading (High Speed).
 - d. Line to Line Voltage: Plus/minus 0.1 percent.
 - 1) 0.1 percent for the one second reading (High Accuracy).
 - 2) 0.2 percent for the 100-millisecond reading (High Speed).
 - e. Current: Plus/minus 0.025 percent.
 - 1) 0.025 percent for the one second reading (High Accuracy).
 - 2) 0.1 percent for the 100-millisecond reading (High Speed).
 - f. Power Factor: Plus/minus 0.2 percent.
 - g. Frequency: Plus/minus 0.01 Hz.
 - 1) Less than 0.01 Hz for the one second reading (High Accuracy).
 - 2) Less than 0.03 Hz for the user programmable 2 to 20 cycle reading (High Speed).
 - h. Auto-calibration capability to correct for temperature dependent affects.
 - 1) Meter self-calibrates once every ten (10) seconds continuously.
 2. Sampling Frequency, Update Rate and Harmonics:
 - a. Sampling frequency: 1024 per cycle (61,440 Hz).
 - b. Update rate for measured parameters:
 - 1) High Accuracy:
 - (a) One second (60 cycles).
 - 2) High Speed:
 - (a) Voltage and Current at 0.1 seconds (10 cycles).
 - (b) Frequency and other parameters at a user settable rate of 0.03 to 0.33 seconds (2 to 20 cycles).
 - c. Harmonics Resolution: 127x of fundamental frequency (127th Order).
 - d. Internal precision real time clock providing max accuracy at full temperature range to plus/minus 3.5ppm. Less than 10 seconds per month clock drift.
 3. Measured Parameters:
 - a. Real energy (kWh); per phase and total of phases.
 - b. Reactive energy (kVARh); per phase and total of phases.
 - c. Apparent energy (kVAh); per phase and total of phases.
 - d. Real power (kW); Average and maximum over a user-specified interval of one hour or less.
 - e. Reactive power (kVAR); Average and maximum over a user-specified interval of one hour or less.
 - f. Apparent power (kVA); Average and maximum over a user-specified interval of one hour or less.
 - g. Bi-directional Energy Measurements:

- 1) Real/active energy (kWh) and apparent energy (kVAh); imported (from the grid), exported (to the grid), and signed net total.
- 2) Reactive energy (kVARh); imported (from the grid) and exported (to the grid), per quadrant as defined by IEEE 1459.
- 3) Maximum demand; real/active power (kW), reactive power (kVAR), and apparent power (kVA); imported (from the grid) and exported (to the grid).
- h. Current; per phase and average of phases.
- i. Voltage; line-to-line and line-to-neutral; per phase and average of phases.
- j. Power factor; per phase and average of phases.
- k. Frequency.
4. Non-Volatile Memory:
 - a. Minimum 4 gigabytes.
 - b. Data stored in non-volatile memory retained for no less than ten (10) years in the event of loss of control power,.
5. Data Logging:
 - a. Real-time clock that allows for time stamping of all logged data:
 - 1) Equipped with thirteen (13) dedicated log files as follows:
 - (a) Eight (8) historical logs for trending profiles. Each log shall be capable of being programmed with up to one hundred twenty-eight (128) parameters. The user shall have the ability to allocate memory between each of the historical logs in order to increase or decrease the memory allotted to each of the logs.
 - (b) One (1) log for Limits Alarms. The Limits log shall provide magnitude and duration of an event, time-stamp, and log value. The log must be capable of recording to 2048 events.
 - (c) One (1) log for System Events. The System Events log shall record the following occurrences with a time-stamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, Programmable Settings Changes, and Critical Data Repairs.
 - (d) One (1) log for I/O changes. The I/O Change log shall provide a time-stamped record of any Relay Outputs and any Input Status changes. The log must be capable of recording up to 2048 events.
 - (e) One (1) log for Waveform Recording.
 - (f) One (1) log for ITIC/CBEMA events which records magnitude and duration of voltage and current surges and sags for every power quality event.
6. Waveform Recording:
 - a. Accuracy:
 - 1) The accuracy of IRIG-B time stamping of waveform capture shall be 100 microseconds.
 - b. Triggering:
 - 1) Up to 16 user settable waveform capture triggers based on percent of full-scale for all measured parameters.
 - 2) Voltage and current trigger setpoints compared against RMS measured values updated on a 1-cycle basis.
 - c. Event Capture:
 - 1) User programmable sampling rates of up to 1024 samples per cycle for waveform capture
 - 2) Pre-event and post-event recording duration configurable up to 179 cycles.
 - 3) Meter stores waveform capture events on a first-in, first-out basis to ensure most recent waveform capture data is always recorded.
 - 4) Integral non-volatile memory available for waveform capture storage.

- d. Sub-Cycle Transient Recorder:
 - 1) Process 50 MHz high-speed voltage transients.
 - 2) Transients will be analyzed utilizing a field programmable gate array (FPGA) to designate the high peak transient magnitude and its duration in nanoseconds.
- 7. Limit Alarms:
 - a. User configurable limit alarm setpoints for any measured parameter.
 - b. Setpoints to be based on percentage of full scale for any measured parameter.
 - c. Up to 32 limit alarm setpoints.
 - d. User configurable limit alarms to map to meter I/O (if equipped).
 - e. User configurable limit alarms to map to remote annunciation (if equipped).
- 8. Meter Inputs/Outputs (I/O):
 - a. Meter to have eight (8) built-in digital high-speed status inputs
 - 1) Inputs automatically sense when the circuit is externally wetted.
 - 2) If externally wetted, inputs accept up to 150 V DC; if internally wetted the meter supplies the necessary voltage for the control application.
 - 3) Status inputs configurable for pulse accumulation, pulse synchronization, or event monitoring. When used for pulse accumulation, each input has an accumulating register to count incoming pulses.
 - 4) Time stamp all changes to the nearest millisecond and placed in an event log with time and event label information.
 - 5) Enable users to recreate sequence of events involving external status points.
 - 6) High-speed status inputs shall be able to trigger waveform recording to the waveform log.
 - 7) Record inputs at 1 cycle RMS and be programmable for (2-20) cycles RMS recording.
 - b. Meters have I/O expandability through four (4) option card slots on the back of the meter and through optional external input/output modules.
 - c. I/O cards capable of being installed in the field, without removing the meter from installation.
 - d. Meters able to auto-detect the presence of any I/O option cards.
 - e. Meter capable of accepting any combination of cards.
 - f. Option card slots accept I/O cards in all of the following formats:
 - 1) Dual RS485/Pulse Output card.
 - 2) Ethernet card with RJ45 or Fiber Optic port with 100BaseT support.
 - 3) Up to two Relay Output cards with 6 output relays on each card.
 - 4) Up to two Digital Input Status cards with 16 inputs on each card.
 - g. Meter to have optional external input/output modules with the following configurations:
 - 1) Supports up to 4 Analog Output Modules in 0-1 mA or 4-20 mA, in either 4 or 8 analog output models.
 - 2) Supports up to one Digital Dry Contact Relay Output Module, with 4 relay outputs.
 - 3) Supports up to 4 Digital Solid State Pulse Output modules for KYZ pulsing.
 - 4) Supports up to 4 Analog Input Modules for external sensing of temperature or process conditions.
 - 5) Able to support 13 external I/O modules.
 - 6) External input/output modules powered by external power source and attached to the meter with mounting brackets. Mounting brackets equipped with DIN Rail mounting clips.
- 9. Communications:
 - a. Compatible with connected systems. Provide all meter expansion cards and accessories necessary for proper interface.

- b. Protocol converters not permitted unless otherwise noted in Design Documentation or this Section.
- c. Serial Communications:
 - 1) Baud rate to be user configurable from 1,200 to 115,200.
 - 2) Support for serial protocols:
 - (a) Modbus ASCII.
 - (b) Modbus RTU.
 - (c) DNP3.
 - (d) BACNet MS/TP via Electro Industries ProtoCom-KT Gateway.
- d. Programming Port::
 - 1) Dedicated programming port to be Universal Serial Bus (USB) type and located on meter faceplate.
- e. Ethernet Communications
 - 1) Standard 10/100BaseT Ethernet port.
 - 2) Optional 2nd Ethernet port to be either 10/100BaseT or 10/100Base-FX fiber optic. See Design Documents for requirements.
 - 3) SNTP time protocol support for high accuracy network time synchronization.
 - 4) Modbus TCP/IP server and Modbus TCP/IP client:
 - (a) Allow the meter to speak with 12 simultaneous sockets of Modbus TCP, so that multiple requests for data can be received simultaneously.
 - 5) DNP:
 - (a) Allow the meter to speak with 5 simultaneous sockets of DNP over TCP/IP so that multiple requests can be handled simultaneously, using standard and optional ports.
 - (b) Allow the meter to speak with both Modbus TCP and DNP over Ethernet simultaneously.
 - 6) Allow auto transmit/receive detection for straight or null RJ45 cables.
 - 7) Provide an embedded Web server that allows access to metered readings through the Internet, using any standard Web browser from a PC, smart phone, or tablet PC.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements are as indicated.
- B. Verify the ratings and configurations of metering systems and associated components are consistent with the indicated requirements.
- C. Verify mounting surfaces are ready to receive meters.
- D. Verify conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Provide required support and attachment components in accordance with Section 26 0529.
- D. Provide grounding and bonding in accordance with Section 26 0526.
- E. Provide fuses complying with Section 26 2813 as required.
- F. Identify meters and associated wiring in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

- D. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.
- E. Correct deficiencies and replace damaged or defective metering system components.
- F. Submit detailed reports indicating inspection and testing results and corrective actions taken.
 - 1. Testing results report to include meter CT polarity and CT/PT phase relationship verification with respect to the metered circuit and associated directionality of current and power flows.

3.04 ADJUSTING

- A. Program system parameters according to requirements of Owner.

3.05 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.

3.07 PROTECTION

- A. Protect installed system components from subsequent construction operations.

END OF SECTION 26 2713

**SECTION 26 2726
WIRING DEVICES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates.
- E. Floor box service fittings.
- F. Poke-through assemblies.
- G. Access floor boxes.

1.02 RELATED REQUIREMENTS

- A. Section 09 6900 - Access Flooring.
- B. Section 26 0533.16 - Boxes for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices.
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- G. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Operation and Maintenance Data:

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide GFCI protection for receptacles installed within 6 feet of sinks.
- E. Provide GFCI protection for receptacles installed in kitchens.
- F. Provide GFCI protection for receptacles serving electric drinking fountains.
- G. For flush floor service fittings, use tile rings for installations in tile floors.
- H. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.02 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: Gray with stainless steel wall plate.
- C. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.

2.03 WALL SWITCHES

- A. Manufacturers:
 - 1. Hubbell Incorporated.
 - 2. Leviton Manufacturing Company, Inc.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc.
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- D. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- E. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- F. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- G. Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.
- H. Locking Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.04 WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton Manufacturing Company, Inc.
 - 2. Lutron Electronics Company, Inc; Maestro Series.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc
- B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

2.05 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated.
 - 2. Leviton Manufacturing Company, Inc.
 - 3. Lutron Electronics Company, Inc; Designer Style.

4. Pass & Seymour, a brand of Legrand North America, Inc
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
 1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 2. Automatically Controlled Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.
 3. Isolated Ground Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.
 4. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 5. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
 6. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
 1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
 4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
 5. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
- E. USB Charging Devices:
 1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
 - a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
 - b. Charging Capacity - Four-Port Devices: 4.2 A, minimum.
 2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.
- F. Surge Protection Receptacles:

1. Surge Protection Receptacles - General Requirements: Listed and labeled as complying with UL 1449, Type 2 or 3.
 - a. Energy Dissipation: Not less than 240 J per mode.
 - b. Protected Modes: L-N, L-G, N-G.
 - c. UL 1449 Voltage Protection Rating (VPR): Not more than 700 V for L-N, L-G modes and 1200 V for N-G mode.
 - d. Diagnostics:
 - 1) Visual Notification: Provide indicator light to report functional status of surge protection.
 2. Standard Surge Protection Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
- G. Exposed Device Color, unless otherwise noted, is as follows:
1. Normal power: Gray or as selected by Architect.
 2. Emergency power: Red.
 3. Standby power: Red.
 4. UPS: Blue.
 5. Isolated ground: Orange.
 6. Surge suppression: Blue.

2.06 WALL PLATES

- A. Manufacturers:
 1. Hubbell Incorporated.
 2. Leviton Manufacturing Company, Inc.
 3. Lutron Electronics Company, Inc.
 4. Pass & Seymour, a brand of Legrand North America, Inc.
- B. Wall Plates: Comply with UL 514D.
 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 2. Size: Standard.
 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- E. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.07 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers:
 1. Hubbell Incorporated.
 2. Thomas & Betts Corporation.
 3. Wiremold, a brand of Legrand North America, Inc.
- B. Description: Service fittings compatible with floor boxes provided under Section 26 0533.16 with components, adapters, and trims required for complete installation.
- C. Above-Floor Service Fittings:
 1. Single Service Pedestal Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle.
 2. Single Service Pedestal Communications Outlets:
 - a. Configuration: One 1 inch bushed opening.

2.08 POKE-THROUGH ASSEMBLIES

- A. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

2.09 ACCESS FLOOR BOXES

- A. Description: Metallic multi-service box suitable for mounting in access floor system specified in Section 09 6900.
- B. Configuration:
 - 1. AFC Cable Systems Inc.
 - 2. Power: Two standard convenience duplex receptacle(s).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements are as indicated.
- B. Verify outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify final surface finishes are complete, including painting.
- E. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of wiring devices provided under this section.
 - 1. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Owner to obtain direction prior to proceeding with work.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.
- I. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

- J. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
- K. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- L. Install wall switches with OFF position down.
- M. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- N. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- O. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- P. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- Q. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- R. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity. Receptacle testing report form example is as follows:

Receptacle Testing and Acceptance Report Form						Date	
Room/Area	Receptacle Test			Ground System Voltage/Impedance		Grounding	Exceptions/Remarks
	Physical Integrity	Polarity	Tension >4oz	New <20m V	Impedance <0.1 Ohms		

- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Inspect each surge protection receptacle to verify surge protection is active.
- G. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 CORD CAPS

END OF SECTION 26 2726

**SECTION 26 2813
FUSES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fuses.
- B. Spare fuse cabinet.

1.02 RELATED REQUIREMENTS

- A. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 26 2413 - Switchboards: Fusible switches.
- C. Section 26 2416 - Panelboards: Fusible switches.
- D. Section 26 2419 - Motor-Control Centers: Fusible switches.
- E. Section 26 2513 - Low-Voltage Busways: Fusible switches.
- F. Section 26 2816.16 - Enclosed Switches: Fusible switches.
- G. Section 26 2913 - Enclosed Controllers: Fusible switches.

1.03 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses.
- B. NFPA 70 - National Electrical Code.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses.
- E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses.
- F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses.
- G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.
- H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - a. Fusible Switches for Switchboards: See Section 26 2413.
 - b. Fusible Switches for Panelboards: See Section 26 2416.
 - c. Fusible Switches for Motor Control Centers: See Section 26 2419.
 - d. Fusible Switches for Busway: See Section 26 2501.
 - e. Fusible Enclosed Switches: See Section 26 2816.16.
 - f. Fusible Switches for Enclosed Motor Controllers: See Section 26 2913.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
 - 1. Spare Fuse Cabinet: Include dimensions.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Fuses: One set(s) of three for each type and size installed.

3. Fuse Pullers: One set(s) compatible with each type and size installed.
4. Spare Fuse Cabinet Keys: Two.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation.
- B. Littelfuse, Inc.
- C. Mersen.
- D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 APPLICATIONS

- A. Service Entrance:
 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
 2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.
- B. Feeders:
 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
 2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.
- C. General Purpose Branch Circuits: Class RK1, time-delay.
- D. Individual Motor Branch Circuits: Class RK1, time-delay.
- E. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.
- F. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
 1. Class RK1, Time-Delay Fuses:
 - a. Products:
 - 1) Substitutions: See Section 01 6000 - Product Requirements.
 2. Class RK1, Fast-Acting, Non-Time-Delay Fuses:
 - a. Products:
 - 1) Substitutions: See Section 01 6000 - Product Requirements.
 3. Class RK5, Time-Delay Fuses:
 - a. Products:
 - 1) Substitutions: See Section 01 6000 - Product Requirements.
 4. Class RK5, Fast-Acting, Non-Time-Delay Fuses:
 - a. Products:
 - 1) _____.

- H. Class J Fuses: Comply with UL 248-8.
 - 1. Class J, Time-Delay Fuses:
 - a. Products:
 - 1) Substitutions: See Section 01 6000 - Product Requirements.
 - 2. Class J, Fast-Acting, Non-Time-Delay Fuses:
 - a. Products:
 - 1) Substitutions: See Section 01 6000 - Product Requirements.
- I. Class L Fuses: Comply with UL 248-10.
 - 1. Class L, Time-Delay Fuses:
 - a. Products:
 - 1) Substitutions: See Section 01 6000 - Product Requirements.
 - 2. Class L, Fast-Acting, Non-Time-Delay Fuses:
 - a. Products:
 - 1) Substitutions: See Section 01 6000 - Product Requirements.
- J. Class T Fuses: Comply with UL 248-15.
 - 1. Products:
 - a. Substitutions: See Section 01 6000 - Product Requirements.
- K. Class CC Fuses: Comply with UL 248-4.
 - 1. Class CC, Time-Delay Fuses:
 - a. Products:
 - 1) Substitutions: See Section 01 6000 - Product Requirements.
 - 2. Class CC, Fast-Acting, Non-Time-Delay Fuses:
 - a. Products:
 - 1) Substitutions: See Section 01 6000 - Product Requirements.
- L. Class _____ Fuses: _____ .
 - 1. Products:
 - a. _____.
 - b. Substitutions: See Section 01 6000 - Product Requirements.
- M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- N. Provide the following accessories where indicated or where required to complete installation:
 - 1. Fuseholders: Compatible with indicated fuses.
 - 2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

2.04 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.
- B. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify mounting surfaces are ready to receive spare fuse cabinet.
- C. Verify conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet where indicated.

D. Identify spare fuse cabinet in accordance with Section 26 0553.

END OF SECTION 26 2813

**SECTION 26 2816.16
ENCLOSED SWITCHES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 0573 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.
- E. Section 26 2813 - Fuses.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- E. NFPA 70 - National Electrical Code.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- H. UL 98 - Enclosed and Dead-Front Switches.
- I. UL 869A - Reference Standard for Service Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
 - 2. Include wiring diagrams showing all factory and field connections.
- D. Field Quality Control Test Reports.

- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Project Record Documents: Record actual locations of enclosed switches.
- G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
 - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

2. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.
3. Minimum Ratings:
 - a. Switches Protected by Class H Fuses: 10,000 rms symmetrical amperes.
 - b. General Duty Single Throw Switches Protected by Class R, Class J, or Class T Fuses: 100,000 rms symmetrical amperes.
 - c. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.
 - d. Double Throw Switches Protected by Class R, Class J, or Class T Fuses: 100,000 rms symmetrical amperes.
- G. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- H. Provide with switch blade contact position that is visible when the cover is open.
- I. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
 1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- J. Conductor Terminations: Suitable for use with the conductors to be installed.
- K. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- L. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- M. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- N. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- O. Heavy Duty Switches:
 1. Comply with NEMA KS 1.
 2. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Provide compression lugs where indicated.
 - c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
 - a. Provide means for locking handle in the ON position where indicated.
- P. Provide the following features and accessories where indicated or where required to complete installation:
 1. Hubs: As required for environment type; sized to accept conduits to be installed.
 2. Integral fuse pullers.
 3. Auxiliary Switch: SPDT switch suitable for connection to system indicated, with auxiliary contact operation before switch blades open and after switch blades close.
 4. Viewing Window: Positioned over switch blades for visual confirmation of contact position with door closed.

5. Interlocked Receptacle: Integral pre-wired three phase, three wire, grounded type receptacle interlocked with switch mechanism to prevent insertion or removal of plug with switch in the ON position and to prevent switch from being placed in the ON position without matching plug inserted. Provide receptacle configuration as required to accept plug as indicated on the drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements are as indicated.
- B. Verify the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify mounting surfaces are ready to receive enclosed safety switches.
- D. Verify conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 0526.
- H. Provide fuses complying with Section 26 2813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J. Identify enclosed switches in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 2816.16

**SECTION 26 2913
ENCLOSED CONTROLLERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
 - 1. Magnetic motor starters.
 - 2. General purpose contactors.
 - 3. Manual motor starters.
 - 4. Motor-starting switches without overload protection.
 - 5. Elevator Power Module
- B. Overcurrent protective devices for motor controllers, including overload relays.
- C. Control accessories:
 - 1. Auxiliary contacts.
 - 2. Pilot devices.
 - 3. Control and timing relays.
 - 4. Control power transformers.
 - 5. Control terminal blocks.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 0573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- D. Section 26 2813 - Fuses: Fuses for fusible switches.
 - 1. Includes requirements for spare fuses and spare fuse cabinets.

1.03 REFERENCE STANDARDS

- A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
- F. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
- G. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- H. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- I. NFPA 70 - National Electrical Code.
- J. UL 98 - Enclosed and Dead-Front Switches.
- K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- L. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules.
- M. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- B. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of enclosed controllers and adjacent equipment with all required clearances indicated.
 2. Include wiring diagrams showing all factory and field connections.
 3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 4. Include documentation of listed series ratings upon request.
 5. Include documentation demonstrating selective coordination upon request.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Field Quality Control Test Reports.
- E. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
 1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
 2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 6000 - Product Requirements, for additional provisions.
 2. Electronic Trip Circuit Breakers: Provide one portable test set.
 3. Indicating Lights: Two of each different type.
 4. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation.
- B. General Electric Company.
- C. Rockwell Automation, Inc; Allen-Bradley Products.
- D. Schneider Electric; Square D Products.
- E. Siemens Industry, Inc.
- F. Substitutions: See Section 01 6000 - Product Requirements.
- G. Source Limitations: Furnish enclosed motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.
 - 1. Motor-starting switches without overload protection may be produced by the same manufacturer as the wiring devices used for this project.

2.02 ENCLOSED CONTROLLERS

- A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.
- D. Service Conditions:
 - 1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
 - a. Altitude:
 - 1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet.
 - 2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
 - 2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
 - a. Altitude: _____ feet.
 - b. Ambient Temperature: Between _____ degrees F and _____ degrees F.
- E. Short Circuit Current Rating:
 - 1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

2. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.
 3. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 4. Label equipment utilizing series ratings as required by NFPA 70.
- F. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures:
1. Comply with NEMA ICS 6.
 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
 - b. Outdoor Locations: Type 3R or Type 4.
 - c. Hazardous (Classified) Locations: Type 7/9, as required for the classification of the installed location.
 3. Finish: Manufacturer's standard unless otherwise indicated.
- I. Instrument Transformers:
1. Comply with IEEE C57.13.
 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 3. Current Transformers: Connect secondaries to shorting terminal blocks.
 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.
- J. General Purpose Contactors: Combination type unless otherwise indicated.
1. Combination Contactors: NEMA ICS 2, Class A combination controllers with magnetic contactor(s) and externally operable disconnect, but without integral overload relay(s).
 2. Noncombination Contactors: NEMA ICS 2, Class A noncombination motor controllers with magnetic contactor(s), but without integral overload relay(s).
 3. Configuration: Full-voltage non-reversing unless otherwise indicated.
 4. Minimum Contactor Size: NEMA Size 0.
 5. Use of non-standard contactor sizes smaller than specified standard NEMA sizes is not permitted.
 6. Disconnects: Circuit breaker type.
 - a. Circuit Breakers: Thermal magnetic unless otherwise indicated or required.
 - b. Disconnect Switches: Fusible type unless otherwise indicated.
 - c. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
 - d. Provide auxiliary interlock for disconnection of external control power sources where applicable.
 7. Pilot Devices Required:
 - a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
 - b. Contactors for motor applications where overload protection is provided separately or where motor contains integral thermal protectors to be provided with pilot devices as specified for magnetic motor starters above.
 - c. Contactors for _____:
 - 1) Pushbuttons: _____.
 - 2) Selector Switches: _____.
 - 3) Indicating Lights: _____.

2.03 POWER MODULE (ELEVATOR SHUNT TRIP)

- A. Motor rated, fused power switch (size as indicated on drawings) with integral shunt trip attachment, control power transformer, control power fuses and blocks, fuse covers, key to test, pilot lights and fire alarm interface relay to NEMA 1 enclosure for emergency shutdown of elevator power. Provide auxiliary contacts for elevator battery lowering device to sense if power module was manually or unintentionally turned off.
- B. Manufacturers:
 - 1. Bussmann PS Series.
 - 2. Littelfuse.
 - 3. Ferrazshaw-Mersen.
 - 4. Or approved.

2.04 OVERCURRENT PROTECTIVE DEVICES

- A. Overload Relays:
 - 1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
 - 2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
 - 3. Trip-free operation.
 - 4. Visible trip indication.
 - 5. Resettable.
 - a. Employ manual reset unless otherwise indicated.
 - b. Employ automatic reset or remote reset where indicated.
 - c. Do not employ automatic reset with two-wire control.
 - 6. Solid-State Overload Relays:
 - a. Basis of Design: _____.
 - b. Selectable inverse-time trip class rating; available ratings of Class 10, 20, and 30, minimum.
 - c. Adjustable full load current.
 - d. Phase loss protection.
 - e. Phase imbalance protection.
 - f. Ground fault protection.
 - g. Ambient temperature insensitive.
 - h. Thermal memory.
 - i. Repeat Trip Accuracy: Plus/minus 2 percent, minimum.
 - j. Trip test function.
 - k. Provide isolated alarm contact.
 - l. Provide communication capability where indicated: Compatible with system indicated.
- B. Fusible Disconnect Switches:
 - 1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
 - 2. Fuse Clips: As required to accept indicated fuses.
 - a. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
 - 3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

C. Circuit Breakers:

1. Interrupting Capacity (not applicable to motor circuit protectors):
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
2. Molded Case Circuit Breakers:
 - a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.
 - 1) Provide thermal magnetic circuit breakers unless otherwise indicated.
 - 2) Provide electronic trip circuit breakers where indicated.
 - b. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - 2) Provide interchangeable trip units where indicated.
 - c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1) Provide the following field-adjustable trip response settings:
 - (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - (b) Long time delay.
 - (c) Short time pickup and delay.
 - (d) Instantaneous pickup.
 - (e) Ground fault pickup and delay where ground fault protection is indicated.
 - d. Provide the following features and accessories where indicated or where required to complete installation:
 - 1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - 2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
 - 3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
 - 4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
 - 5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.05 CONTROL ACCESSORIES

A. Auxiliary Contacts:

1. Comply with NEMA ICS 5.
2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:

1. Comply with NEMA ICS 5; heavy-duty type.

2. Nominal Size: 30 mm.
 3. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
 4. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
 5. Indicating Lights: Push-to-test type unless otherwise indicated.
 6. Provide LED lamp source for indicating lights and illuminated devices.
- C. Control and Timing Relays:
1. Comply with NEMA ICS 5.
 2. Provide number and type of relays indicated or required to perform necessary functions.
 3. Timing Relays: Electronic or pneumatic as indicated.
 - a. Adjustable Timing Range: As indicated on drawings.
 4. Multi-Speed Motor Starters: Employ accelerating relays, decelerating relays, and compelling relays where indicated.
 5. Accelerating Relays: Starts motor at low speed and then accelerates automatically through definite time intervals for each successive speed until selected speed is attained.
 6. Decelerating Relays: Allows motor to decelerate automatically through definite time intervals for each successive speed until selected speed is attained.
 7. Compelling Relays: Requires motor to start at low speed before a higher speed can be selected.
- D. Control Power Transformers:
1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus _____ VA spare capacity.
 2. Include primary and secondary fuses.
- E. Control Terminal Blocks: Include 25 percent spare terminals.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements are as indicated.
- B. Verify ratings of enclosed controllers are consistent with the indicated requirements.
- C. Verify mounting surfaces are ready to receive enclosed controllers.
- D. Verify conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install controllers in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Install enclosed controllers plumb and level.
- E. Provide grounding and bonding in accordance with Section 26 0526.
- F. Install all field-installed devices, components, and accessories.
- G. Provide fuses complying with Section 26 2813 for fusible switches as indicated.
- H. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- I. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.
- J. Set field-adjustable circuit breaker tripping function settings as indicated.
- K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 0573.
- L. Identify enclosed controllers in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.
 - 1. Verify motor-running protection.
 - 2. Perform insulation-resistance tests on all control wiring with respect to ground.
- E. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- F. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than _____ amperes. Tests listed as optional are not required.
 - 1. Perform insulation-resistance tests on all control wiring with respect to ground.
 - 2. Test functions of the trip unit by means of secondary injection.
- G. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.
- H. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of enclosed controllers and associated devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.

3.07 PROTECTION

- A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION 26 2913

**SECTION 26 4300
SURGE PROTECTIVE DEVICES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surge protective devices for service entrance locations.
- B. Surge protective devices for distribution locations.
- C. Surge protective devices for branch panelboard locations.

1.02 SUMMARY

- A. Surge Protective Devices (SPD) for low voltage power equipment and provide effective high energy protection against transient surges, temporary over-voltages, voltage swells and high frequency noise attenuation.
- B. This Section describes the materials and installation requirements for Surge Protective Devices (SPD). SPD's are used for the protection of AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.
- C. This specification also describes the mechanical and the electrical requirements for the SPD. Suitable for application in both category A, B, and C environments as described in ANSI/IEEE C62.41- 2002.
- D. Furnish and install the Surge Protective Devices having the electrical characteristics, ratings and modifications as specified herein and as shown on the contract documents. Provide related hardware (i.e. flush mounting kits, mounting brackets, etc.) as required for the installation of the SPD system suitable for the application.

1.03 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 2300 - Low-Voltage Switchgear.
- C. Section 26 2413 - Switchboards.
- D. Section 26 2416 - Panelboards.
- E. Section 26 2419 - Motor-Control Centers.
- F. Section 26 2513 - Low-Voltage Busways.

1.04 ABBREVIATIONS AND ACRONYMS

- A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- B. SPD: Surge Protective Device.

1.05 REFERENCE STANDARDS

- A. IEEE C62.41.1 - IEEE Standard Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
- B. ISO 9001 - Quality Management Systems — Requirements.
- C. MIL-STD-220 - Method of Insertion Loss Measurement.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- G. NFPA 70 - National Electrical Code.
- H. UL 1283 - Standard for Electromagnetic Interference Filters.
- I. UL 1449 - Standard for Surge Protective Devices.
- J. ANSI - American National Standards Institute

1. ANSI C84.1 - American National Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hz).
- K. IEEE - Institute of Electrical and Electronics Engineers
 1. IEEE C62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
 2. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
 3. IEEE C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
 4. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book).
 5. IEEE 1100 - Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book).
- L. ISO - International Organization for Standardization
 1. ISO 9001 - Quality Management System.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.07 SUBMITTALS

- A. See Section 26 0500 - Common Work Results for Electrical, for submittal procedures.
- B. Include written specification response referencing each specification section and sub-section indicating compliance or non-compliance. If manufacturer cannot fully comply with specification section, this must be stated in the response along with a full description of the variance.
- C. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
 1. SPDs with EMI/RFI filter: Include noise attenuation performance.
- D. Shop Drawings: Include wiring diagrams showing factory and field connections with wire and circuit breaker/fuse sizes.
- E. Certificates: U.L. VZCA file documentation of listing for compliance with the following standards:
 1. UL 1449.
 2. UL 1283 (for Type 2 SPDs).
- F. Published specifications, cut sheets and product data with appropriate IEEE C62.41 and UL 1449 (current edition) performance ratings for intended installation locations.
- G. Field Quality Control Test Reports.
- H. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- I. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.
- J. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

- K. Project Record Documents: Record actual connections and locations of surge protective devices.

1.08 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Qualifications:
 - 1. UL 1449 (current edition) compliance and listing through U.L. Type 1 compliance required for SPD intended for installation before (or after) Main Service Disconnect or Type 2 compliance for installation after Main Service Disconnect. Provide published UL 1449 (current edition) Nominal Discharge Current Rating and Voltage Protection Rating.
 - 2. Local representation and distribution within 400 miles of the project location to provide technical, warranty claim, and installation support for the project.
 - 3. Manufacturer/vendor must be capable of supplying SPD for project within 30 days of receipt of order for orders of 25 units and less for models submitted in response to this specification.
 - 4. Certified to latest ISO 9001 standard and registered for the design and manufacturing of SPD devices.
 - 5. Provide access to a readily available factory engineer for answering questions about this product.
 - 6. Only firms regularly engaged in the manufacture of SPD products for category C locations (ANSI/IEEE C62.41.1-2002), and whose products have been providing satisfactory service for not less than five years, considered. Upon request, provide a customer reference list, with a minimum of five contact names and current phone numbers.
 - 7. Provide manufacturer qualifications as part of the submittal.
 - 8. The successful manufacturer/vendor to assign a technical contact person for SPD application, installation, and warranty questions. Contact available to provide a response to a technical question within a maximum of two business days.
 - 9. Single manufacturer capable of providing power system SPD's.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.09 DELIVERY, STORAGE, AND PROTECTION

- A. Inspect for damage and replace any damaged device.
- B. Store in a clean, dry space suitable for equipment and protect against damage. Store in accordance with manufacturer's written instructions.
- C. Clean equipment and touch up minor scratches using suitable materials.

1.10 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.11 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Period: 10 years from the date of substantial completion of service and activation of the system to which the SPD is attached.
- C. Full replacement of a suppressor which is damaged or fails to meet manufacturers published specifications and specifications provided within, without pro-rating value.
- D. No exclusions from failure or damage from any system anomaly (over-voltage, single phasing, lightning strike, etc. (IEEE C62.41.1)).

- E. Exceptions: Failure caused by wiring error, loose, or missing Neutral to Ground Bond or Megger Testing with SPD connected to power system.
- F. Factory or third party testing not required.
- G. Warranty applies independent of facility ownership / purchaser.
- H. Replacement unit to be at facility within 7 business days of receipt of written notification of failure at no cost to the customer (exception – custom configuration or special order units).
- I. Replacements: same make, model and configuration as original unit unless otherwise requested or approved.
- J. Manufacturer site visit for validation of warranty claim: manufacturer/vendor must visit site within 3 days of notification at no cost.
- K. No shipping, handling, examination or other fees are allowed.
- L. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: _____.
- B. Field-installed, Externally Mounted Surge Protective Devices:
 1. ABB/GE .
 2. Advanced Protection Technologies, Inc (APT).
 3. Current Technology; a brand of Thomas & Betts Power Solutions .
 4. nVent ERICO; _____: www.nvent.com/#sle.
 5. Schneider Electric; Square D Brand Surgelogic Products .
 6. Surge Suppression, LLC (SSI); _____: www.surgesuppression.com/#sle.
- C. Factory-installed, Internally Mounted Surge Protective Devices:
 1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.
- D. Substitutions: See Section 01 6000 - Product Requirements.
- E. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.
- F. This listing of specific manufacturers above does not imply acceptance of their products which do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

- A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.
- B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.
- C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- D. Utilize Metal-Oxide Varistors (MOV) components as primary energy mitigation. Selenium cell, air gaps, gas tubes are not allowed.
- E. Performance and Ratings:
 1. Minimum durability and performance requirements are described below in accordance with test procedures outlined in ANSI/IEEE C62.45 and UL 1449 (current edition). Provide test documentation as part of the submittal package. Provide information in a format which is easily to analyze and review. Submit the following test data as manufacturer published literature:

- a. Provide Peak Surge Current (Single Pulse Rated, 8/20 μ S, by mode, Amperes) with submittals document for each SPD proposed. For electrical equipment located at Service Entrance or Category C locations, Surge current rating a minimum of 160kA per phase / 80kA per mode for IEEE C62.41.1-2002 - Category C Low Exposure locations and 300kA per phase / 150kA per mode for IEEE C62.41.1-2002-Category C High Exposure locations or critical locations.
 - b. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G and N-G) with submittals.
 - c. Surge Current Rating: Minimum of 80kA per phase / 40kA per mode in low exposure locations or 120kA per phase / 60kA per mode for distribution switchboards or motor control centers in medium and high exposure / critical equipment locations and for IEEE C62.41.1-2002 - Category B and C Switchboard and Motor Control Center Locations.
 - d. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G and N-G) with submittals.
 - e. Surge Current Rating:
 - 1) Minimum of 80kA per phase / 40kA per mode for branch panel models in low, medium and high exposure areas and for IEEE C62.41.1-2002 - Category B and C Panel and Sub-Panel Locations.
 - f. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G and N-G) with submittals.
 - g. For each SPD proposed, provide published durability test data utilizing the ANSI/IEEE C62.41-1991, Category C3, 20kV/10kA, 1.2 x 50 μ S - 8x20 μ S combination waveform for SPD durability tests with (as a minimum), the ANSI/IEEE C62.41-1991, Category C1, 6kV/3kA, 1.2 x 50 μ S - 8x20 μ S combination waveform used for pre and posttest measurement of let through performance variation. Provide test data with submittals, including test setup information.
 - h. SPD devices withstand a minimum of 15,000 IEEE C3 20kV/10kA hits delivered at a rate not exceeding one pulse per minute without failure or degradation exceeding 5 percent using IEEE B3 6kV/3kA combination waveform for pre and post durability let through measurement evaluation. Lead length for testing and let through measurements, 6-inchs.
 - i. UL Third Edition Nominal Discharge Current Ratings a minimum of 20kA per mode for SPD's to be installed at the Service Entrance (or where direct lightning strike potential exists on outdoor feeder or branch circuit conductors serving electrical equipment) and a minimum of 10kA per mode for all other locations.
 - j. Provide EMI/RFI Attenuation as per Mil Std-220. Attenuation 40dB at 100 kHz.
- F. Protected Modes:
- 1. Wye Systems: L-N, L-G, N-G, L-L.
 - 2. Delta & High Resistance Grounded Systems: L-G, L-L.
 - 3. Single Split Phase Systems: L-N, L-G, N-G, L-L.
 - 4. High Leg Delta Systems: L-N, L-G, N-G, L-L.
- G. UL 1449 Voltage Protection Ratings (VPRs):
- 1. Equivalent to basis of design.
 - 2. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
 - 3. 240/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
 - 4. 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.

5. 480V Delta System Voltage: Not more than 1,800 V for L-G mode and 3,000 V for L-L mode.
6. 600Y/347V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,500 V for L-L mode.
- H. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage or 125% for 120/208 volt systems.
- I. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 1. Indoor clean, dry locations: Type 1.
 2. Outdoor locations: Type 3R.
- J. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
 1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
 2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.
- K. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
 1. Switchgear: See Section 26 2300.
 2. Switchboards: See Section 26 2413.
 3. Panelboards: See Section 26 2416.
 4. Motor Control Centers: See Section 26 2419.
 5. Busway Plug-in Units: See Section 26 2513.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

- A. Surge Protective Device:
 1. Protection Circuits: Field-replaceable modular or non-modular.
 2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
 3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
 4. UL 1449 Short Circuit Current Rating (SCCR): Not less than 200 kA.
 5. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

2.04 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

- A. Surge Protective Device:
 1. Protection Circuits: Field-replaceable modular or non-modular.
 2. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.
 3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
 4. UL 1449 Short Circuit Current Rating (SCCR): Not less than 200 kA.
 5. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Optional: Provide button to manually silence audible alarm.
- B. As a minimum, Branch Panel, Sub-Panel, and series installed (branch circuit) SPD includes a passive circuit which allows the SPD to actively follow the voltage waveform and provide a clamping envelope to limit low level IEEE C62.41 Category A ring waves (of either polarity) at all locations on the sine wave. Circuit to perform in the Neutral to Ground Mode.

2.05 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

- A. Surge Protective Device:
 - 1. Protection Circuits: Field-replaceable modular or non-modular.
 - 2. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
 - 3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
 - 4. UL 1449 Short Circuit Current Rating (SCCR): Not less than 200 kA.
 - 5. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

2.06 DIAGNOSTICS:

- A. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
- B. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
- C. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.

2.07 ENCLOSURE

- A. NEMA rated metal enclosure appropriate for environmental conditions and exposure at point of installation.
- B. Designed to allow connection of the SPD without sharp bends in the conductors.
- C. Metal flush kits for flush mount installations (external devices) on new and retrofit applications for panels. Include supports for fastening to structural members and include a faceplate matching SPD finish. Retrofit kits capable of being installed next to the panel after drywall has been installed without the need for patching or refinishing of the wall.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements are as indicated.
- B. Verify the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
- C. Verify electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.
- D. Verify system grounding and bonding is in accordance with Section 26 0526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- E. Verify conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

- E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.
- F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 0526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.
- G. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.
- H. Service Entrance Installation Requirements
 1. One primary suppressor at each utility service entrance to the facility or as indicated on the drawings.
 2. Unless otherwise indicated, connect surge protective device to properly rated disconnect (including overcurrent and short circuit protective device) on the load side of the service entrance disconnecting means in accordance with NEC requirements.
 3. Conductors between suppressor and point of attachment kept as short and straight as possible and group together (via tie wrap) where possible. Lead length of connecting conductor not to exceed 2 feet without written permission of the Engineer.
 4. Bond suppressor's ground to enclosure frame and the service entrance ground bus, and conduit between the SPD and the switchboard must provide secure electrical/mechanical connections.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS Section 7.19.1.
- D. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.04 CLEANING

- A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 4300

**SECTION 26 5000
LIGHTING**

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Lenses.
 - 2. Reflector Cones.
 - 3. Housings.
 - 4. Finish.
 - 5. Suspension.
 - 6. Lamps and Sockets.
 - 7. Power Supplies.
 - 8. Emergency LED Drivers.
 - 9. Transformers.
 - 10. Track Lighting Systems.
 - 11. Custom Luminaires.
 - 12. Exterior Luminaires.
 - 13. Extra Material.
 - 14. Disposal and Replacement.

1.02 DEFINITIONS

- A. BACNET - Protocol for integration with BAS/BMS/EMS.
- B. BAS - Building Automation System.
- C. BMS - Building Management System.
- D. EMS - Energy Management System.
- E. CCT- Correlated Color Temperature.
- F. CRI - Color Rendering Index.
- G. CS - Control Station.
- H. D - Dimming Wall Switch.
- I. DT - Dual Technology (PIR + U).
- J. FC - Footcandles.
 - 1. The metric for measuring illuminance light levels.
 - 2. GUI - Graphic User Interface.
 - 3. LCP - Lighting Control Panel.
 - 4. LED - Light Emitting Diode.
 - 5. LonWorks - Protocol for integration with BAS/BMS/EMS.
 - 6. MTBF - Minimum Time Between Failures.
 - a. Total hours of testing / Number of failures.
 - 7. OS/VS - Occupancy Sensor / Vacancy Sensor.
 - a. Occupancy sensors provide automatic on and automatic shut-off.
 - b. Vacancy sensors provide automatic shut-off only, and require manual-on.
 - 8. PC - Photocell.
 - 9. PIR - Passive Infrared Technology.
 - 10. Power Supply Ballasts and LED drivers.
 - 11. RS - RS-232 Connection for AV Integration.
 - 12. SC - Scene Control.
 - 13. TC - Timeclock, or astronomical timeclock.
 - 14. U - Ultrasonic Technology.

15. WS - Wall Switch.
16. WS/O - Wallbox Occupancy Sensor Switch.
 - a. Wall Switch with integrated Occupancy Sensor.

1.03 REFERENCE STANDARDS

- A. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts.
- B. ANSI E1.11 - Entertainment Technology - USITT DMX512-A - Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories.
- C. ANSI E1.20 - Entertainment Technology - RDM - Remote Device Management over DMX512 Networks.
- D. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- E. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code).
- F. IEC 60929 - AC and/or DC-Supplied Electronic Control Gear for Tubular Fluorescent Lamps - Performance Requirements.
- G. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products.
- H. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources.
- I. NFPA 70 - National Electrical Code.
- J. TIA-485 - Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.
- K. UL 924 - Emergency Lighting and Power Equipment.

1.04 QUALITY ASSURANCE

- A. The lighting design for this project was based on luminaire types and manufacturers as specified.
- B. Basis of Design manufacturers are pre-qualified to bid on products where specified. Inclusion of manufacturer and product series does not relieve specified manufacturer from providing product as described in luminaire schedule; modifications to standard product, if required, include with initial bid.
- C. Alternate manufacturers listed in the Luminaire Schedule do not require prior approval but included with the shop drawing submittal. Inclusion of manufacturer and product series as an alternate does not relieve the manufacturer from providing product equivalent to the basis of design as described in luminaire schedule; modifications to standard product, if required, include with initial bid.
- D. Or Approved or Pre-Bid Approved Equal:
 1. Submit Substitution Request prior to bid, complying with requirements of Division 01, General Requirements.
 2. Approval determined by review of the following luminaire characteristics where applicable. Lack of pertinent data on characteristic constitutes justification for rejection of the submittal.
 - a. Performance:
 - 1) Distribution.
 - 2) Utilization.
 - 3) Average brightness/maximum brightness.
 - 4) Spacing to mounting height ratio.
 - 5) Visual comfort probability.
 - b. Construction:
 - 1) Engineering.
 - 2) Workmanship.

- 3) Rigidity.
- 4) Permanence of materials and finishes.
- c. Installation Ease:
 - 1) Captive parts and captive hardware.
 - 2) Provision for leveling.
 - 3) Through-wiring ease.
- d. Maintenance:
 - 1) Relamping ease.
 - 2) Ease of replacement of ballast and lamp sockets.
- e. Appearance:
 - 1) Architectural integration.
 - 2) Light tightness.
 - 3) Neat, trim styling.
 - 4) Conformance with design intent.

1.05 GENERAL REQUIREMENTS

- A. Provide lighting outlets indicated on the Drawings with a luminaire of the type designated and appropriate for the location.
- B. Where a luminaire type designation has been omitted and cannot be determined by the Contractor, request a clarification from the Architect in writing and provide a suitable luminaire type as directed.
- C. Coordinate installation of luminaires with the ceiling installation and other trades to provide a total system that is neat and orderly in appearance.
- D. Luminaires located in fire rated assemblies rated for use in such assemblies or have assembly maintained by the installer through the use of appropriate construction techniques to maintain the assembly rating. It is the responsibility of the Contractor to maintain the assembly rating and provide required components during construction. Coordinate luminaires impacted with Division 01, General Requirements, and life safety documents.
- E. Install remote power supplies and transformers in enclosures as required by luminaire specified. Locate remote power supplies and transformers as shown on drawings; where no location is shown, provide recommendation for approval prior to commencing field installation. Locate remote mounted power supplies and transformers within the distance limitations specified by the manufacturer.
- F. Exterior pole lights have an appropriated pole base as part of the assembly. For pole lights in pedestrian areas, use a flush pole base. Pole lights in parking areas a raised base used. Pole bases, footings, and structural components reviewed and approved by a state licensed structural engineer prior to ordering and installation.
- G. Linear lighting elements installed on building exterior, in coves, soffits, panels and other architectural materials are the longest sections available to meet the intent of the design and centered in the available space. Other items required to make the lights function installed out of site and coordinated with Architect, Landscape Architect, Lighting Designer, and Electrical Engineer of Record. Transformers, drivers, and ballasts in suitable enclosures. Required connection points are the minimum box or connector available from the manufacturer. Standard electrical boxes are not allowed to produce linear runs in architectural coves. Ancillary material required is concealed from view. Coordinate final ceiling material, dimensions, and limitations with the ceiling manufacturer prior to ordering and installation.
- H. Coordinate voltage requirements to each luminaire as indicated on drawings.
- I. Verify luminaires carry a valid UL or ETL listing. Luminaires located in outdoor locations to carry and appropriate wet or damp listing as required for the mounting application.

- J. Procure luminaires through a distributor located within 200 miles of the project site with a valid business license in the state the project is located.
- K. Upon request of the Architect, Engineer, or Owner, provide back-up pricing in a unit cost breakdown per luminaire. Back-up pricing includes distributor net pricing, Contractor net pricing, final Owner pricing and mark-ups and discounts (lot price or all-or-none) associated with the luminaires.
- L. Lighting related change orders to include back-up pricing noted above for review by the Engineer and Lighting Designer.
- M. Provide manufacturer's warranty covering 5 years on drivers from date of purchase. Luminaire manufacture to operate driver at or below the required driver warranty temperature. Luminaire manufacturers failing to operate the driver, at the project required ambient temperature and within the driver manufacturer warranty parameters will be responsible for driver warranty related costs over the warranty period.
- N. 80 percent of the luminaire material by weight at a minimum should be recyclable at end of life. Design luminaire for ease of component replacement and end-of-life disassembly.

1.06 SUBMITTALS

- A. Submit the following in accordance with Section 26 0500 - Common Work Results for Electrical:
 - 1. Shop Drawings, to include:
 - a. Product Data.
 - 1) Provide manufacturer's published product data information.
 - 2) This information is to be relevant to the specified product only.
 - 3) Submittals limited to not more than three sheets for each type specified.
 - 4) They are specifically not to have configurations available included for review.
 - 5) Submittals that contain information that is not relevant to the product specified will be rejected in total and resubmission will be required.
 - b. Luminaire dimensions on a fully dimensioned line drawing.
 - c. Lamp information, including array configuration:
 - 1) For LED lamps: proof of conformance with the following: ANSI C78.377-2015, IES LM-79-2008, IES LM-80-2008, IES LM 82-2012, IES LM 84-14, IES LM 85-14, IES TM 21-2011, IES TM 28-14 and special certifications required by the contract documents.
 - d. Lamp socket information.
 - e. Power supply and transformer information using ballast manufacturers published product data information. Multiple power supplies or transformers may be submitted for single luminaire if compatible with specification included in contract documents. Include certification of lamp and power supply and transformer compatibility for submitted.
 - f. Mounting details including clips, canopies, supports, and methods for attachment to structure. Provide equipment required for row configurations.
 - g. UL/ETL Labeling Information
 - h. Manufacturer's Warranty
 - i. Photometric Reports consisting of the following:
 - 1) Candlepower distribution curves: Provide five plane candlepower distribution data at no more than 5 degree vertical angle increments.
 - 2) Coefficient of utilization table.
 - 3) Zonal lumen summary including overall luminaire efficiency.
 - 4) Luminaire luminance: Provide measured maximum brightness data for luminaires with reflectors and average brightness data for luminaires with refractors.

- 5) Spacing to mounting height ratio. If parallel and perpendicular ratios differ, provide data on each plane.
 - 6) Pole information to include maximum supported effective projected area (EPA) and weight for the design wind speed, as well as structural calculations for each pole proposed.
 - 7) VCP calculations (where applicable): For general office lighting luminaires, provide typical VCP calculations for ceiling heights between 9-feet and 12-feet at 1-foot increments, for room sizes 20-feet by 20-feet and 30-feet by 30-feet.
- j. Special requirements of the specification.
2. Operation and Maintenance Data:
 - a. Prepare two copies of a Lighting Systems Maintenance Manual consisting of the following in a hard-cover binder for review. After review, Architect will deliver one copy to Owner. Manual to include:
 - 1) One complete set of final submittals of actual product installed, including product data and shop drawings. Include product data for actual power supply and transformer installed where applicable.
 - 2) List of lamps used in Project, cross-referenced to fixture types, with specific manufacturer's names and ordering codes.
 - 3) Re-lamping instructions for lamps that require special precautions (LED, tungsten halogen, metal halide, etc.).
 - 4) Lighting fixture cleaning instruction, including chemicals to be used or avoided.
 - 5) Parts list of major luminaire components and ordering information for replacement
 - 6) Copies of manufacturer warranties on product.
 3. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.
 4. Manufacturer's Installation Instructions:
 - a. Indicate application conditions and limitations of use stipulated by product testing agency.
 - b. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
 5. Closeout Submittals:
 - a. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.
 - b. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
 - c. Maintenance Materials: Furnish for Owner's use in maintenance of project.

PART 2 PRODUCTS

2.01 GENERAL

- A. Luminaires new and complete with mounting accessories, junction boxes, trims, and lamps.
- B. Luminaire assemblies UL listed.
- C. Luminaires UL listed appropriate to mounting conditions and application.
- D. Each luminaire family type (downlights, troffers, etc.) supplied by only one manufacturer.
- E. Install recessed luminaires in fire rated ceilings and use a fire rated protective cover thermally protected for this application and carry a fire rated listing.
- F. Luminaires installed under canopies, roofs, or open areas and similar damp or wet locations to be UL listed and labeled as suitable for damp or wet locations.

2.02 LENSES

- A. Mechanically secured from within the housing.

- B. Interior linear prisms with smooth exterior.
- C. Prismatic Acrylic:
 1. 12-inch by 24-inches and Larger: Extruded of clear virgin acrylic plastic, 0.125-inch minimum overall thickness, 0.1-inch nominal unpenetrated thickness, Pattern 12 with flat sided female prisms running at 45 degrees off panel axis unless otherwise specified in the luminaire schedule. Concave prisms are not acceptable.
 2. 12-inch by 24-inches and Larger: Low brightness type, extruded of clear virgin acrylic plastic, 0.156-inch minimum overall thickness, 0.1-inch nominal unpenetrated thickness, Pattern 19 with flat sided male prisms running parallel with panel axis unless otherwise specified in the luminaire schedule. Concave prisms are not acceptable.
 3. 12-inch by 24-inch and Larger: Injection molded of clear virgin acrylic plastic, 0.16-inch minimum overall thickness with 0.125-inch nominal unpenetrated thickness square cone base, similar to Pattern 12 configuration.
 4. As specified in the Luminaire Schedule.
- D. Opal Acrylic:
 1. Extruded or injection molded of virgin acrylic plastic, 0.08-inch minimum overall thickness.
 2. As specified in the Luminaire Schedule.
- E. Opal Acrylic Overlay: High transmittance type, extruded of virgin acrylic plastic, 0.04-inch overall thickness, with minimum 80 percent light transmittance.

2.03 REFLECTOR CONES

- A. Spun of uniform gauge aluminum, free of spinning marks or other defects.
- B. Integral trim flange.
- C. Color and finish as specified in Luminaire Schedule.
- D. White Reflectors:
 1. Steel or aluminum, minimum 22 gauge, with hard baked white enamel finish with minimum 85 percent reflectance.
- E. Alzak Reflectors:
 1. Low iridescent specular or as indicated in the luminaire schedule, Alzak or Coilzak with minimum reflectance of 90 percent.
 2. Supply luminaires using Alzak reflector cones by the same manufacturer unless directed otherwise in Luminaire Schedule.

2.04 HOUSINGS

- A. Dimensions:
 1. Proper for the various wattage noted on the plans and as recommended by the luminaire manufacturer or as specified in the luminaire schedule.
- B. Extruded Aluminum Housing:
 1. One piece housing of AA 6063 T5 extruded aluminum with 0.14 minimum thickness smooth and free of tooling lines in one uninterrupted section of 1-foot to 24-foot with the cross sectional dimensions as indicated in the Luminaire Schedule.
 2. Section lengths as shown on the drawings and able to be transported into and out of the installation location after final construction without building demolition being required.
- C. Steel Housing:
 1. 20 gauge minimum, free of dents, scratches, or other defects.
 2. Fill and sand exposed weld marks, joints, and seams smooth before finishing. Clean and dress edges to remove sharp edges or burrs.
 3. Section lengths as shown on the drawings comprised of 1-foot to 12-foot lengths.
- D. Sheet Metal Housings:
 1. Minimum 22 gauge cold-rolled steel, with welded joints. Exposed weld marks and seams filled and ground smooth.

- E. Door Frames for lensed luminaires:
 - 1. White painted, flat aluminum with mitered corners, rotary cam latches to hinge from either side.
- F. End Plates:
 - 1. Mechanical attach die cast end plates without exposed fasteners. End caps, minimum 0.125-inch thick.
- G. Provide an internal alignment spline where housing sections are joined together to form a continuous row.
- H. Recessed Luminaires
 - 1. Rated for use in recessed applications.
 - 2. If required by the Owner or design team, the manufacturer must produce test data proving the product is rated for use in recessed applications.
 - 3. Equip with through wire junction box. Box, power supply, and replaceable components accessible from the ceiling opening of the luminaire.
- I. Luminaires used as air-handling registers for HVAC systems meet the requirements of NFPA 90A.
- J. For wet and damp use, LED-based luminaire to be sealed, rated, and tested for appropriate environmental conditions and may not be accomplished by using an additional housing or enclosure.

2.05 FINISH

- A. Visible surfaces to be of color and texture as directed in Luminaire Schedule.
 - 1. Baked white dry polyester powder, if not specified, with a minimum average reflectance of 85 percent on exposed and light reflecting surfaces.
- B. Concealed interior and exterior luminaire surfaces to be Matte black or as recommended by the luminaire manufacturer.
- C. Prepare steel components for finishing with a 5-step zinc phosphating process prior to painting.
- D. Paint luminaire (including painted component parts) after fabrication unless specifically noted in the Luminaire Schedule.
- E. Exposed aluminum surfaces:
 - 1. Satin etched and clear anodized.
 - 2. Treat with an acid wash and clear water rinse prior to painting.
 - 3. Electrostatically paint or powder coat and oven bake in the color indicated in the Luminaire Schedule.
- F. Exposed steel surfaces:
 - 1. Treat with acid wash and clear water rinse, then prime coat.
 - 2. Electrostatically paint or powder coat and oven bake in the color indicated in the Luminaire Schedule.

2.06 SUSPENSION

- A. Suspension Devices, type as specified in the Luminaire Schedule:
 - 1. Aircraft Cable:
 - a. Stainless steel type - 3/32-inch nominal diameter, stranded, with positive pressure, field adjustable clamp at fixture connection.
 - 2. Rigid Pendant:
 - a. 1/2-inch nominal diameter or as specifically shown on drawings.
 - b. Supplied by fixture manufacturer when available as standard product.
 - c. At fixture end of stems, provide earthquake type swivel fitting to permit 45 degree swing in any direction away from vertical.
 - d. Flat canopy to permit splice inspection after installation.
 - 3. Chain Hangers:

- a. Length to suit fixture mounting height if shown or as field conditions dictate.
- b. Use two heavy duty chains with S hooks at each suspension point.
- c. Length to suit mounting height as shown on Drawings.
- 4. Suspension system must permit $\pm 1/2$ -inch minimum vertical adjustment after installation.
- B. Supports:
 - 1. Provide internal safety cable from fixture body to structure.
 - 2. Carry fixture weight to structure and provide horizontal bracing from suspension points to ceiling framing to prevent sideways shifting. Provide diagonal seismic restraint wires per code.
- C. Feed Point:
 - 1. Flat-plate canopy to cover outlet box, with holes for support cable and power cord, concealed fasteners to permit splice inspection after installation.
 - 2. At the electrified connection provide straight cord feed. Provide a separate feed point where emergency feed is required.
 - 3. Power Cord:
 - a. White multi-conductor cord, parallel to support cable (aircraft cable); within pendant (rigid pendant); or flexible conduit (chain hanger).
 - 4. Provide a separate fee point where emergency feed is required.
- D. Non-feed Points:
 - 1. 1/2-inch OD polished chrome end sleeve, inside threaded 1/4-inch-20, with 2 -inch diameter. Flat white plate to cover hole in ceiling. Top of cable with ball swaged on end, to fit inside sleeve.
 - 2. Provide support above ceiling as required.
- E. Suspension method allows adjustment to be made in hanging length to allow for variance in ceiling height.
- F. Exposed paintable suspension components have the same finish and color as the luminaire housing.

2.07 LAMPS AND SOCKETS

- A. Lamp each luminaire with the suitable lamp cataloged for the specific luminaire type and as indicated by the manufacturer, or as specifically indicated in the Luminaire Schedule, or as specified herein.
- B. Lamps to be field replaceable.
- C. Lamp sockets to be of configuration and design to accept standard LED lamps and circuit boards.
- D. LED lamps to meet or exceed 50,000 hours as defined by LM-80-08 based on both the ambient temperature listed and the LEDs B10L70 performance curve as published by the LED lamp manufacturer.
- E. LED lamps to be high brightness and proven quality from established and reputable LED manufacturers, including:
 - 1. Nichia.
 - 2. Osram-SemiOpto.
 - 3. Cree.
 - 4. Philips Lumileds.
 - 5. Seoul Semiconductor.
 - 6. Bridgelux.
 - 7. General Electric Gelcore.
 - 8. Xicato.
 - 9. Osram.
- F. Replacement Lamps:

1. Sorra.
 2. Toshiba.
- G. LED lamps that are integral into the housing; light bars, diodes, boards and other, to be rated and tested for use in the fixture specified and compatible with the driver tested and compatible with that fixture.
- H. Screw-In Base Replacement LED Lamps:
1. Manufacturer to provide wattage restriction label on socket, equivalent to specified wattage on LED replacement lamp.
 2. LED replacement lamps not to be placed in air-tight enclosures or in insulated air tight (ICAT) rated luminaire enclosures without dedicated heat dissipation and thermal management of the luminaire system.
- I. Color Rendering Index (CRI):
1. 80 or higher for ambient lighting in common spaces.
 2. 90 or higher for accent lighting in common spaces.
 3. 95 or higher for art lighting.
 4. As indicated in the luminaire schedule.
- J. Color Rendering Index (CRI): 90+ per ANSI C78.377-2008/CIE 13.3-1995 unless noted otherwise on the luminaire schedule.
- K. Correlated Color Temperature (CCT) per luminaire schedule:
1. Color consistency not to exceed a +/- tolerance of greater than two MacAdam Ellipses over the life of the luminaire.
- L. Adjustable Lamp Mechanisms: To have aiming stops which can be permanently set to position lamp vertically and rotationally.
- M. High power LED luminaire thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware
- N. Operating Temperature: -22 degrees F to 115 degrees F.:
1. Operate below manufacturer's published die junction temperatures when operated at 1W at 350 mA in an elevated ambient of 46 degrees C.
- O. Utilize quick-connect connections to replaceable boards to meet ANSI and UL/ETL and NEMA requirements.

2.08 POWER SUPPLIES

- A. UL recognized under the component program and modular for simple field replacement.
- B. Rate for use with the LED array specified:
1. Warranty array and driver as an assembly.
 2. 5 year full replacement, non-pro-rated warranty is required on electronic components.
- C. Luminaires requiring more than one driver are not permitted, unless specified in the luminaire schedule.
- D. Power supplies used in enclosed and gasketed luminaires listed for use in wet locations, Type 1 construction.
- E. Rate for the expected ambient temperature in which they are installed:
1. Exterior installed power supplies rated to start the lamps at 0 degrees F.
- F. Operate for a (+/- 10 percent) supply voltage of 120V through 277VAC at 60Hz.
- G. Power Factor: 0.9 minimum.
- H. Lifetime minimum:
1. 50,000 hours at full load and 77 degrees F ambient.
 2. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
- I. Minimum time between failures (MTBF) greater than 300,000 hours at full load and 77 degrees F ambient, in accordance with MIL-HDBK-217.

- J. Driver and luminaire electronics deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10):
 - 1. Flicker index to be less than 5 percent at frequencies below 1000 Hz.
- K. Label systems using tandem wired luminaires be labeled accordingly. Locate label in the lamp compartment of each luminaire and identify the function of that luminaire. Do not make the label visible from room.
- L. Total Harmonic Distortion less than 20 percent and meet ANSI C82.11 maximum allowable THD requirements at full output. At no point in the dimming curve allow imbalance current to exceed full output THD.
- M. Meet or exceed 30mA2s at 277VAC for up to 50Ws of load and 75A at 240us at 277VAC for 100 watts of load.
- N. Withstand up to a 1,000V surge without impairment of performance as defined by ANSI C62.41 Category A.
- O. Housing have circuit diagrams and lamp connections applied thereto.
- P. Must be Reduction of Hazardous Substances (RoHS) compliant
- Q. Provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.
- R. Support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
 - 1. Adjustment of forward LED voltage, supporting 3V through 55V.
 - 2. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA.
 - 3. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.
- S. Remote: Driver may be remote mounted up to 300-feet depending on power level and wire gauge.
- T. Dimming Drivers:
 - 1. Dimming power supplies controlled by a common controller provided by the same manufacturer.
 - 2. Manufacturer to have minimum 5 years' experience in manufacturing of dimmable electronic lighting drivers.
 - 3. LED dimming to be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment.
 - a. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
 - 4. Provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0 percent relative light output, or 100 - 1 percent light output and step to 0 percent where indicated. Driver responds similarly when raising from 0 percent to 100 percent.
 - a. Driver to be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.
 - 5. Track evenly across multiple fixtures at light levels, and provide input signal to output light level that allow smooth adjustment over the entire dimming range.
 - 6. Limit inrush current.
 - 7. No visible change in light output with a variation of plus/minus 10 percent line voltage input.

8. Ability to configure a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
9. Basis of Design Product: eldoLED or subject to compliance and prior approval with specified requirements of this section, one of the following:
 - a. eldoLED.
 - b. Philips.
 - c. Osram Sylvania.
 - d. Tridonic.
 - e. General Electric.
10. Dimming Protocols:
 - a. If not otherwise noted on the luminaire schedule, dimming LED drivers to be 0-10V.
 - b. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
 - 1) Must meet IEC 60929 Annex E for General White Lighting LED drivers.
 - 2) Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
 - 3) Must meet ESTA E1.3 for RGBW LED drivers.
 - 4) 0-10V input protected from line voltage miswire, and immune and output unresponsive to induced AC voltage on the control leads.
 - c. Digital (DALI Low Voltage Controlled) Dimming Drivers
 - 1) Must meet IEC 62386.
 - d. Digital Multiplex (DMX Low Voltage Controlled) Dimming Drivers
 - 1) Must meet DMX / RDM: ANSI/TIA-485, ANSI E1.11 - USITT DMX512A and ANSI E1.20 (Explore and Address)
 - 2) Capable of signal interpolation and smoothing of color and intensity transitions.
 - 3) Luminaires requiring more than one driver are not permitted.
 - 4) Drivers may be connected to the DMX bus by a T-tap spur not to exceed 12-inch in absolute length. In other cases, a DMX input and output connection must be provided.
 - e. As indicated in the luminaire schedule.

2.09 EMERGENCY LED DRIVERS

- A. Consist of a high-temperature, replaceable maintenance-free nickel cadmium battery, integral charger, and electronic circuitry enclosed in single compact case. Provide solid-state charging indicator light to monitor the charger and battery, a double-pole test switch, and installation hardware.
- B. Emergency driver operates lamps for a minimum of 90 minutes in the emergency mode. Lumen output at end of 90 minutes, 60 percent of initial lumen output per UL 924.
- C. UL listed for installation either inside or on top of the luminaire and be warranted for a full five years from date of installation.
- D. Install and wire by the luminaire manufacturer unless specified for field installation in the Luminaire Schedule.
- E. Wire as either Nightlight (always on) or switchable (with power failure sensing feed) as shown on the drawings.
- F. Mount in accordance with manufacturer's installation requirements.
- G. Initial lumen output to be full output of the luminaire rating.

2.10 TRANSFORMERS

- A. Provide proper lamp voltage to low voltage lamps.
 1. Integral:

- a. Magnetic: Encapsulated for silent operation, securely mounted to the luminaire and removable through the aperture for hard ceiling installations or remote where shown on drawings.
 - b. Electronic: Do not provide electronic transformers unless directed in the Luminaire Schedule.
2. Remote:
- a. Magnetic:
 - 1) Encapsulated for silent operation, securely mounted accessible in location shown on drawings.
 - 2) Provide code-sized primary and secondary circuit protection via fuses, quantity of secondary circuits as required to serve specified load.
 - b. Electronic:
 - 1) Do not provide electronic transformers unless directed in the Luminaire Schedule.

2.11 TRACK LIGHTING SYSTEMS

- A. Lighting Track:
 - 1. Extruded aluminum track with extruded poly-vinyl insulator.
 - 2. 20A, copper conductor strips with separate ground to provide electrical and mechanical connection for the specified track mounted luminaires.
 - 3. Number of circuits as indicated in luminaire schedule, with separate neutrals per circuit.
 - 4. Provide connectors, elbows, stems, feed ends, end caps and fittings to make a complete system.
- B. Track Fittings:
 - 1. Provide positive mechanical and electrical connection for track heads to track.
 - 2. Removable fitting either twists into or snaps into specified lighting track.
- C. Luminaire dimensions: Proper for the various wattage noted on the plans and as recommended by the luminaire manufacturer or as specified.
- D. Adjustable Lamp Mechanisms:
 - 1. Adjustable aiming which can be set to position lamp vertically and rotationally.
- E. Transformers:
 - 1. Provide proper lamp voltage to low voltage lamps.
 - 2. Magnetic transformers encapsulated for silent operation.
 - 3. Integrally mount Magnetic and electronic transformers to luminaire.
- F. Finish: Visible surfaces to be of color and texture as directed in Luminaire Schedule.
- G. Labels: Track and track fittings compatible and be UL labeled and listed as a system.

2.12 CUSTOM LUMINAIRES

- A. Custom luminaire manufacturer no less than five years of continuous experience in the design and manufacture of custom lighting elements of the type and quality shown.
- B. Specifications and drawings are intended to convey the features, function and character of the custom luminaire only and do not necessarily illustrate every component or detail required in the finished piece of equipment.
- C. Include details and components that are necessary for the proper appearance and functioning of the custom luminaire.
- D. Provide operational sample prototype luminaire for review and revision, if specified, of each custom luminaire type. Install and connect sample prototype luminaire by the Contractor in a mutually acceptable location for demonstration and evaluation by the design team. Final judges on determining whether the prototype sample complies with specification is up to the Architect and Lighting Consultant.

2.13 EXTERIOR LUMINAIRES

- A. Label fixtures from the factory for use in the designed installation. It is the responsibility of the Contractor to verify labeling and installation requirements with the NEC and applicable codes and standards.
 - 1. External Label: ANSI C136.15
 - 2. Luminaires must have locality-appropriate governing mark and certification.
- B. The luminaire must be subjected to 100,000 cycles of 2 Gs at the resonant frequency of the luminaire (between 5 and 30 Hz) applied at the center of gravity of the luminaire on three primary axes per ANSI C136.31 without damage to the luminaire. Fully functional luminaire upon completing the test.
- C. Luminaire must be IP and/or UL-listed for damp or wet locations, as appropriate for exterior application, and wiring cavity must be field accessible for service or repair needs.
- D. Provide luminaires fully assembled and electrically tested before shipment from factory.
- E. Optical cavity must be a minimum IEC 60529/IP65.
- F. Rate luminaires for -4 degrees F to 104 degrees F operation.
- G. The coating must be capable of surviving ASTM B117 Salt Fog environment for 500 hour minimum without blistering or peeling. The coating must demonstrate gloss retention of greater than or equal to 90 percent for 500 hour exposure QUV test per ASTM G53 UVB313, 4 hour UV-B 140 degrees F/4 hour condensation 122 degrees F.
- H. Provide luminaires with a NEMA distribution pattern as indicated in the luminaire schedule.
- I. Water feature and fountain lighting to meet applicable codes and regulations.
- J. Project Conditions Coordination:
 - 1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under Work of Other Sections, or by others.
 - 2. Coordinate elevation to obtain specified foundation height.
 - 3. Notify Owner of conflicts or deviations; obtain direction prior to proceeding with Work.
- K. Exterior Lenses
 - 1. In-grade lenses drive-over and cool touch rated.
 - 2. For lenses not integral to the LED lamp, construct the luminaire optical enclosure (lens/window) of clear and UV-resistant polycarbonate, acrylic, or glass.
- L. Unless otherwise indicated, provide cast-in-place embedded style concrete foundations with constructed forms for square foundations or round foundations with spirally wrapped treated paper forms. Provide concrete, anchor bolts, and reinforcing steel as indicated in the Drawings.
- M. Poles:
 - 1. Provide poles of material and form as indicated in the luminaire schedule. Provide poles able to withstand winds of not less than 100 mph and a gust factor of 1.3 with an ice load criteria up to 1/2-inch thick without damage to the pole and attached luminaire.
 - 2. Provide poles with a hand-hole and removable hand-hole coverplate that matches the material and finish of the pole. Install covers with vandal resistant bolts. Locate hand-hole located approximately 18-inches above the pole base.
 - 3. Provide poles with provisions for installation of Owner provided and installed security cameras. Provide hand-hole with removable hand-hole coverplate that matches the material and finish of the pole. Locate hand-hole based on Owner design of security cameras.
 - 4. Provide poles with an internal ground lug easily accessible from the hand-hole.
 - 5. Provide poles with a base plate welded to the pole utilizing a backup ring and full-penetration welded connection.
 - 6. Provide a one piece base cover to completely cover foundation hardware.
 - 7. Aluminum Poles:

- a. Seamless extruded aluminum shafts fully welded to a cast aluminum anchor base assembly.
 - 1) Provide shaft square, straight, and meeting requirements of AASHTO Standard Specifications.
 - 2) Pole Height: As indicated in the Luminaire Schedule.
- 8. Pole Finish:
 - a. Provide external surfaces of the pole, base cover, support arms, and luminaires finished in the same material and color.
 - b. Provide poles chemically cleaned, rinsed, phosphatized, sealed, and dried.
 - c. Apply an electrostatic application of polyester-power paint to external surfaces.
 - d. Oven-bake complete unit to form a homogeneous, non-porous surface. Provide completed finish with no sags, drips, oxidation, or runs.
- 9. Anchor Bolts: Provided by pole manufacturer of size and length and quantity as recommended by pole manufacturer.
 - a. Fabricate anchor bolts from hot rolled carbon steel bar with an L bend on one end.
 - b. Provide galvanized anchor bolts with a minimum of 12-inches on the threaded end.
 - c. Provide bolt circle and bolt projection dimensions with manufacturer's Shop Drawings.
- 10. Wrap poles in a protective material for shipment to the Project site.

2.14 EXTRA MATERIAL

- A. Furnish extra materials described below that match product installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Glass and plastic lenses, covers, louvers, globes, guards, and other removable fixture parts: 5 percent or one dozen (whichever is less) of each type and rating installed. Furnish at least one of each type.
 - 2. Control gear: 5 percent or one dozen (whichever is less) of each field-replaceable control module, driver, ballast, or individual fixture transformer. For fixtures with non-easily replaceable control gear provide 5 percent or one dozen (whichever is less) extra fixtures. Confirm non-replaceable products during submittal process.
 - 3. Adjustable accent lights (track, recessed, or surface mounted): 10 percent of each beam angle lens (or removable lens accessory), 10 percent or one dozen (whichever is less) additional accessory lenses, color filters, louvers, and other accessories specified for use during final focusing.
 - 4. For non-decorative LED lights, provide 2 percent additional fixtures, or minimum two fixtures.
 - 5. Touch-Up Paint: 2 gallons, to match color of pole finish.

2.15 DISPOSAL AND REPLACEMENT

- A. LED manufacturer is responsible for the disposal of expired LED arrays and heat sinks. Clearly label fixture with return information, disposal procedures and manufacturer disposal contact information.
- B. Owner will pay for shipping.
- C. Manufacturer is required to inform the Owner of new power requirements and /or lumen output values if new replacement components prior to shipping replacement parts.
- D. Label disposal and replacement information inside the luminaire and in the project operation and maintenance manuals along with O&M requirements listed in Division 01, General Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Meet general requirements of NFPA 70, National Electric Code.

- B. Mounting heights specified on drawings:
 - 1. Wall Mounted Luminaires:
 - a. Centerline of luminaire.
 - 2. Pendant Mounted Luminaires:
 - a. Bottom of luminaire unless specifically identified in the Luminaire Schedule or on drawings.
- C. Support:
 - 1. Support by separate means from the building structure and not from the ceiling system, ductwork, piping, or other systems.
 - 2. Final decision as to adequacy of support and alignment will be given by the Architect.
- D. Power Supplies:
 - 1. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - a. Ambient temperature: -4 degrees to 122 degrees F.
 - b. Relative humidity: Maximum 90 percent, non-condensing.
 - c. Protected from dust and excess moisture during installation.
 - 2. Install per manufacturers prescribed methods.
 - 3. Located remote mounted power supplies and transformers within the distance limitations specified by the power supply manufacturer.
- E. Level luminaires, align in straight lines, and locate as shown on the architectural elevations and reflected ceiling plan.
- F. Manufacturer's labels or monograms not visible after luminaire is installed, but must be included for future reference.
- G. Recessed Luminaires:
 - 1. Trims which fit neatly and tightly to the surfaces in which they are installed without light leaks or gaps.
 - 2. Install heat resistant non-rubber gaskets to prevent light leaks or moisture from entering between luminaires trim and the surface to which they are mounted.
- H. Pole Luminaires:
 - 1. Provide cast-in-place concrete foundations for pole mounted luminaires.
 - 2. Concrete: As specified in Division 03, Concrete.
 - 3. Foundation Forms: As indicated.
 - 4. Place anchor bolts in foundation as recommended by manufacturer in the required bolt circle size.
 - 5. Tie reinforcing steel in foundation to the anchor bolts to form a solid cage.
 - 6. Tamp wet concrete during pouring to assure complete coverage below, around and within the cage and form.
 - 7. Hand finish top of foundation to produce a smooth, level surface.
 - 8. Provide a minimum 10-foot copper-clad steel ground rod at each pole base. Connect from ground rod to the ground lug in the pole with minimum AWG 8 copper conductor.
 - 9. Install pole mounted luminaires plumb with luminaires level, and with reflector distribution in the direction indicated in the Drawings.
 - a. Grout around the pole base at the foundation to close openings.
 - b. Install pole base cover over exposed installation hardware.
- I. Tungsten Halogen Lamps:
 - 1. When lamping tungsten halogen luminaires use silk gloves to insert lamps.
 - 2. Do not energize tungsten halogen luminaires during construction to prevent dust build up on lamp, socket and lamp chamber. Lamping occurs as last stage of construction.

3.02 COORDINATION OF WORK

- A. Architectural Reflected Ceiling Plans take preference as to the exact placement of the luminaires in the ceiling.
- B. Determine ceiling types in each area and provide suitable accessories and mounting frames where required for recessed luminaires. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed.

3.03 AIMING

- A. Aim luminaires with proper lamps installed.
- B. Aim directional luminaires, including but not limited to luminaires described in the Contract Documents or by the luminaire manufacturer as aimable, adjustable, or asymmetric as follows:
 - 1. Provide the lighting pattern for which the luminaire is designed.
 - 2. Provide the lighting pattern as shown on the drawings.
 - 3. Predetermined aiming points as shown on the drawings.
 - 4. Where aiming cannot be determined, request, in writing, clarification from the Architect, indicating luminaires needing clarification.
- C. Re-aim luminaires as determined by Architect during final project walkthrough.
- D. Install adjustable luminaires with dead zone of rotation away from intended aiming point.

3.04 PROJECT CLOSEOUT

- A. Leave luminaires clean at the time of acceptance of the work. If luminaires are deemed dirty by the Architect at completion of the work, clean them at no additional cost. Protective plastic wrap is to be removed from parabolic luminaires just prior to Owner acceptance.
- B. Provide fixtures with new lamps operating at time of final acceptance. Exception: For fluorescent dimming fixtures, provide minimum 100 hour/maximum 200 hour, continuously lit lamps or per ballast manufacturer's recommendations.
- C. Where incandescent lamps are used for construction lighting, replace the lamps with new lamps just prior to occupancy by the Owner.

END OF SECTION 26 5000

**SECTION 28 0500
COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY**

PART 1 GENERAL

1.01 SUMMARY

- A. The intent of this Division's Specifications and Drawings is to provide a complete and workable facility, with complete systems as required by applicable codes, as indicated, and as specified.
- B. Provide a complete and workable facility with complete systems that comply with the requirements of the state codes, local codes, and other authorities having jurisdiction. Include design, labor and materials required to install, test and place into operation the systems as called for in the Contract Documents and according to applicable codes and regulations.
- C. Specifications and the accompanying Drawings are complementary and what is called for by one is as binding as if called for by both.
- D. The scope of work includes:
 - 1. Pathway, boxes, and cabling for an Owner provided design
 - 2. Documentation and project coordination for an owner provided design
- E. Work done under this Division of the specifications includes the furnishing of labor, material, equipment, and tools required for the complete installation of the work indicated on the Drawings or as specified herein.
 - 1. Provide all connections, raceway, wiring, and installation required for systems specified, as required by the manufacturers installation documents, and for complete system functionality.
 - 2. Follow the Drawings as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions, and without additional cost to the Owner. Significant deviations from the routing shown on the drawings is subject for approval prior to installation. The right is reserved by the design team to make reasonable changes in locations of system components prior to roughing-in, without cost impact.
 - 3. Verify dimensions, field conditions, quantities, and measurements prior to installing work.
 - 4. Do not reduce the size or number of conduit runs indicated on the Drawings without the written approval of the Owner.
- F. Work installed contrary to Drawings and Specifications is subject to change as directed by the Owner and no extra compensation will be allowed for making those changes.

1.02 PRICE AND PAYMENT PROCEDURES

- A. Allowances
 - 1. Comply with Division 01, General Requirements.
- B. Alternates
 - 1. Comply with Division 01, General Requirements.
 - 2. Refer to Drawings for detailed information relating to the appropriate alternates.

1.03 RELATED SECTIONS

- A. Division 00, Procurement and Contracting Requirements
- B. Division 01, General Requirements
- C. Division 07, Thermal and Moisture Protection
- D. Division 08, Openings
- E. Division 11, Equipment
- F. Division 26, Electrical
- G. Division 27, Communications
- H. Division 28, Electronic Safety and Security

1.04 REFERENCE STANDARDS

- A. Refer to individual Division 28 Specification Sections for applicable reference standards abbreviations, acronyms and definitions.

1.05 CONTRACTOR REQUIREMENTS

- A. Coordination:
 - 1. Review Drawings of other trades and Owner provided equipment to avoid conflicts.
 - 2. Report potential conflicts to Architect, provide resolution prior to rough-in.
 - 3. Architectural Drawings take precedence regarding exact placement of system components and equipment.
 - 4. Verify the physical dimensions of equipment to fit the space available.
 - 5. Coordinate access routes through the construction, equipment move-in planning, and provide all required equipment, transport and services necessary to facilitate installation of equipment.
 - 6. Where connections are required for equipment provided as Work of other Divisions, coordinate rough in and connection requirements for that equipment with its supplier and installer prior to commencing work.
 - 7. Coordinate underground work with other trades working on the site.
 - a. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained.
 - 8. Coordinate installation of required supporting devices and set sleeves in architectural and structural components as they are constructed.
 - 9. Coordinate location of access panels and doors for items concealed behind finished surfaces with Architect.
 - 10. Coordinate sleeve selection and application with firestopping specified elsewhere.
 - 11. Coordinate finishes with Architect, finish to match surrounding surfaces.
 - 12. Coordinate arrangement, mounting, and support of communications equipment with Architect, Communication Design Professional or Owner Information Technology Team.
 - 13. Coordinate with owner's IT department for IP addresses and network configuration.
- B. Project Management
 - 1. Designate a project manager to act as the single point of contact. Project manager to oversee work performed to ensure a quality installation compliant with specifications as outlined in documents (which includes specifications and drawings). Owner or Consulting Engineer will review a copy of the resume of the on-site project managers and each on-site team.
 - 2. Contractor project manager/supervisor to attend meetings arranged by General Contractor, Architect, Owner's representatives, and/or other parties affected by work of this specification.
- C. Pre-installation Conference
 - 1. Arrange and schedule pre-installation conference prior to beginning work of this Section Division 28, Electronic Safety and Security.
 - 2. Agenda: Clarify questions in writing related to work to be performed, scheduling, coordination, etc., with Consultant and/or Project Manager/Owner representative.
 - 3. Individuals, who will be in an on-site supervisory capacity, are required to attend the pre-installation conference. This includes project managers, site supervisor, and lead installers. Individuals who do not attend the conference will not be permitted to supervise the personnel that install, terminate, or test communications cables on the project. Oversee the installation is required to attend the pre-installation conference.
- D. Examination of building and site responsibility:

1. Examine site and building prior to installation to determine conditions affecting the scope of work.
 - a. Prior to bidding, verify and become familiar with existing conditions by visiting the site.
 - b. Include related costs associated with site factors in the initial bid proposal.
 2. Systems and cabling are assumed working and in good condition unless Contractor documents exceptions.
 3. Respect and protect the privacy and confidentiality of Owner, its employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the State of Oregon and Owner policies.
- E. Use of Sub-Contractors:
1. Inform in writing to Owner's representative and General Contractor about the intention to use sub-contractors and the scope of work for which they are being hired.
 2. Owner's representative prior to the sub-contractor's hiring and start of work must approve the use of sub-contractors in writing.

1.06 SUBMITTALS

- A. General:
1. Submit for approval the details of materials, equipment, and systems to be furnished.
 - a. Submittal Category:
 - 1) Pre-Bid and Informational Submittals
 - 2) Equipment/Product Data Submittals:
 - 3) Delegated Design Submittals (See 28 30 00 Fire Detection and Alarm)
 - 4) Shop Drawings
 - 5) Closeout Submittals
 2. Develop a cable testing plan for approval and final submittal of systems.
 3. Do not proceed Work without the Owner and/or the Project Manager's approval of the submitted items.
 4. Partial submittals will not be considered, reviewed, or stored, and such submittals will not be returned.
 5. Materials and equipment listed that are not in accordance with specification requirements and/or not prior approved may be rejected.
 6. The approval of material, equipment, systems, and shop drawings is a general approval subject to the Drawings, Specifications, and verification of measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. Carefully check and correct shop drawings prior to submission for approval.
 7. Substantial completion will not be granted until Functional Testing reports have been carried out and accepted.
- B. Equipment/Product Data Submittals:
1. Submit a single package of Division 28, Electronic Safety and Security product data.
 2. Provide and indexed set of manufacturer's technical data for each product including product description, specifications including labeling or listing by an agency acceptable to the Owner, and storage requirements.
 3. For each applicable section within the Division 28, Electronic Safety and Security, organize as follows:
 - a. Cover sheet for each applicable section number.
 - 1) Include the contractor's contact information
 - b. Table of contents with the following information per line:
 - 1) Equipment Type
 - 2) Manufacturer
 - 3) Model Number

- 4) Page Number (with hyperlink to product data sheet's page)
- c. Apply header to each page of each section's submittals including the following:
 - 1) Title of division 28 section the products fall under (e.g. 281300 Access Controls.
- d. Apply footer to the bottom of each submittal package including the following:
 - 1) Clearly labeled page numbers
 - 2) Date of submittal (YYYY-MM-DD)
- 4. Where more than one product is called out on the same sheet, clearly highlight or mark which product is proposed for use.
- 5. Include product data for materials that are not listed in the contract documents but are required for a complete and functioning cable infrastructure system.
- C. Pre-Bid and Informational Submittals
 - 1. If required, submit integrator qualifications, licensing, resumes and service information along with proposal.
 - 2. Substitution Requests
 - a. Submit Questions and Substitution Requests before the Questions deadline, defined in Division 00 and Division 01.
- D. Shop Drawings:
 - 1. General:
 - a. Assemble complete submittal package for this Division into a single submittal.
 - 1) Partial submittals will not be accepted.
 - b. Prepare project-specific information, drawn accurately to scale.
 - c. Submit shop drawings for review prior to beginning fabrication.
 - 1) Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.
 - d. Sheet Size: Match sheet size of Construction Drawings.
 - e. Prepare in two-dimensional format utilizing the software program, version, and operating system compatible with those used to develop the Construction Drawings.
 - f. Include architectural information on the shop drawings:
 - 1) Match Lines
 - 2) Grid Lines
 - 3) Grid Bubbles
 - 4) Key Plans
 - 5) Enlarged Floor Plan Callouts
 - 2. Original bid/contract documents are not to be used as shop drawings. Generate three-dimensional original shop drawings utilizing CAD software (i.e. AutoCAD, Revit, etc.). Shop drawings that appear to be traces or overlays of original bid contract documents may be rejected without review.
 - 3. Where scope is distributed among multiple sub-contractors, provide detailed references between submittal packages where connections exist between sub-contractor's documents.
 - a. Example: Contractor A provides System X shop drawings. Contractor B provides System Y shop drawings. Both sets of shop drawings must make references to each other where systems X or Y are interdependent on each other to function.
 - 4. Cover Sheet:
 - a. The first page of shop drawings shall include a coversheet containing the following information:
 - 1) Site Information:
 - (a) Name of Site
 - (b) Address
 - (c) City

- (d) Zip Code
 - 2) Installing Contractor's Information:
 - (a) Business Name
 - (b) Local Office Address
 - (c) Phone Number
 - (d) Website
 - (e) Primary Contact Person:
 - (1) Name
 - (2) Phone Number
 - (3) Email Address
 - 3) Sheet index
5. Legends:
- a. Symbols:
 - 1) Include an associated symbol for each device used on the symbol legend, including but not limited to the following:
 - (a) Symbol Name
 - (b) Device Description
 - (c) Rough-in Requirements
 - (d) Applicable Manufacturer
 - (e) Manufacturer's Model Number
 - b. Wiring:
 - 1) Include an associated symbol for each wire used on the symbol legend, including but not limited to the following:
 - (a) Cable Designator
 - (b) Cable Manufacturer
 - (c) Model Number
 - (d) Cable Rating (e.g. CMP, CMR, OSP, etc.)
 - (e) Size of Conductors
 - (f) Quantity of Conductors
 - 2) Use a different designation for each cable type.1
6. Plans and Elevations:
- a. Plan Views:
 - 1) Devices, cabinets, racks, and termination blocks.
 - 2) Raceways (conduits, cable trays, ladder racks, floor ducts, junction boxes, pull boxes, splice boxes, manholes, and associated supports).
 - 3) Field devices with their respective address number.
 - 4) Equipment clearances for racks/cabinets.
 - b. Elevation Views:
 - 1) Rack Layouts
 - (a) Intended equipment layout within the racks.
 - (b) Blank filler plates in spaces where equipment is not installed.
 - (c) Areas within the rack for equipment furnished by or reserved by others.
 - (d) Indicate rack unit size of equipment, and total rack units available in the rack.
7. Details and Diagrams:
- a. Details:
 - 1) Mounting details for head-end equipment, racks, and field devices.
 - b. Diagrams:
 - 1) Associated one-line or riser diagram showing connections between devices and connections to equipment provided in other systems.

- 2) Show field devices with their respective room names/numbers and connections to their associated equipment.
 - 3) Show field devices with their respective address number.
 - 4) Show IP addresses for TCP/IP devices included in the system.
8. System Labeling Schedules:
- a. Electronic copy of labeling schedules, in software and format selected by Owner.
 - b. Closeout Submittal Category:
 - 1) Maintenance Contracts
 - 2) Operations and Maintenance Data
 - 3) Bonds
 - 4) Warranty Documentation
 - 5) Final Test and Evaluation Reports
 - 6) Record Documentation
 - 7) Demonstration and Training
 - 8) Sustainable Design Closeout
 - 9) Software
- E. Closeout Submittals
1. General
 - a. Provide digital (i.e. PDF) copy via email / project file sharing platform.
 - b. Include full manuals of equipment provided (data sheets alone not acceptable).
 - c. Include IP addresses for TCP/IP devices included in the system.
 2. Functional Testing and Evaluation Reports
 - a. Provide Functional Testing and Evaluation Reports as describe on 3.04 FUNCTIONAL TESTING AND DEMONSTRATION below.
 - b. Submit a minimum of 2 weeks prior to final punch walkthrough. Maintain test equipment on-site during punch for sample proof-of-performance tests.
 3. Operation and Maintenance Data.
 - a. Manufacturer's Installation, Start-Up, and Adjustment Instructions.
 - b. Update to the Equipment/Product Data Submittals with identical document structure and digital document requirements.
 - c. Include equipment schedule of installed components, arranged by installation location, and including manufacturer, model number and serial number(s).
 - d. Include original software configuration files and programming software for head-end equipment.
 - 1) Software files consist of both the original "un-compiled" file used for creating the system, as well as the compiled firmware/instructions that are loaded onto the head-end equipment/device.
 - e. Schedule of usernames and passwords for equipment and software provided under this section.
 - f. Special Warranty:
 - 1) With respect to the installation of Approved Manufacturer's Cabling System, furnish Approved Manufacturer's Cabling System application / system standard warranty.
 - 2) Provide instructions for initiating claims / repair work under warranty, including names, contact information, and required contract numbers
 4. Record copy and as-built drawings.

- a. Provide record copy drawings periodically throughout the project as requested by the General Contractor or Owner, and digitally at the end of the project. Provide Record copy drawings at the end of the project in PDF, in addition to CAD (AutoCAD or Revit) format and include notations reflecting the as built conditions of additions to or variation from the drawings provided (e.g. cable paths and termination points). Incorporate test data imported from the test instruments into CAD drawings.
- b. As-built drawings include, but are not limited to: block diagrams, frame and cable labeling, cable termination points, equipment room layouts, rack elevations, and frame installation details. The as-built drawings include field changes made up to construction completion:
 - 1) Field directed changes to cross connect and patching schedule.
 - 2) Horizontal cable routing changes.
 - 3) Backbone cable routing or location changes, inclusive outside plant physical pathways (if within scope of this project).
 - 4) Associated detail drawings.

1.07 QUALITY ASSURANCE

- A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- B. Equipment and materials required for installation under these Specifications shall be the manufacturer's current model, new, unused, and without blemish or defect.
- C. When more than one unit of the same class of equipment or material is required, use products of a single manufacturer or partner manufacturers that offer a certified solution.
- D. Equipment shall bear labels attesting to Underwriters Laboratories or certification by other recognized laboratory, where subject to label service. Manufacturers of equipment and materials pertinent to these items have been engaged in the manufacture of said equipment a minimum of three years and, if so directed by the Owner, be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.
- E. Provide UL and/or ETL approved and labeled products in accordance with NEC for products where labeling service normally applies.
- F. Label materials and equipment requiring UL 94, 149, or 1863. Modification of products that nullifies UL labels is not permitted.
- G. Perform the following field inspections during installation and commissioning:
 1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings.
 2. Visually inspect cabling placements, pathways, and terminations in communications equipment rooms, telecommunications rooms, and work areas for compliance with standards and codes.
 3. Visually inspect grounding and bonding for compliance with standards and codes.
 4. Visually inspect installed cable trays, cable pathways, and wall penetrations for compliance with standards and codes.

1.08 WARRANTY

- A. See Division 01 for additional warranty requirements.
- B. Provide a written guarantee covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.
- C. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.
- D. Correct warranty items promptly upon notification.
- E. Apparatus:

1. Free of defects of material and workmanship and in accord with the Contract Documents.
2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Equipment in these Sections are the standard products of a manufacturer regularly engaged in the manufacture of such products unless specified otherwise. Components used in the system commercial products that comply with these Specifications.
- B. Each component of equipment identifies the manufacturer's name, model, and applicable serial number. The Owner's authorized representative retains the right to reject products that reflect, in their opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.

PART 3 EXECUTION

3.01 EXAMINATION OF CONDITIONS

- A. Prior to the start of work, carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.
- B. Install equipment in accordance with applicable codes and regulations, the original design, and the referenced standards.
- C. In the event of a discrepancy, immediately notify the Project Manager.
- D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.
- E. Verify dimensions, field conditions, quantities, and measurements prior to installing work. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering cabling and associated hardware. Notify the Engineer of discrepancies.

3.02 DEMOLITION AND SALVAGE

- A. General:
 1. Where affected by work, remove or relocate equipment, services, and systems encountered during the course of the remodel/construction work to a safe location that will be undisrupted by further construction.
- B. Salvage and Disposal:
 1. Removed materials, not containing hazardous waste, not scheduled for reuse are the property of the Contractor for removal from the site, except for those items specifically indicated on the Drawings for salvage or reuse.
 2. Identify materials containing, or possibly containing, hazardous waste for removal and disposal by the Hazardous Waste Contractor.
 3. Neatly store salvaged items at one location at the site where directed by the Owner's Representative.

3.03 INSTALLATION

- A. Refer to individual Division 28 Specification Sections for Additional Installation Requirements.
- B. Install cabling systems to neither generate nor be susceptible to electromagnetic emission, radiation, or induction that degrades cabling systems.
- C. Install equipment level and true. Provide housekeeping pads and curbs accounting for floor or roof slope.

3.04 ACCESS TO EQUIPMENT

- A. Install equipment in location and manner that will allow convenient access for maintenance and inspection.

- B. Working spaces not less than specified in the National Electrical Code (NEC) for voltages specified.
- C. Where the Project Manager determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment removed and reinstalled, one time only, as directed by the Project Manager, at no additional cost to the Owner. Conveniently accessible is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and ductwork.

3.05 DELIVERY, STORAGE, AND HANDLING

- A. Assume custody and responsibility for the items upon delivery and determining that the contents are complete and in satisfactory condition for installation.
- B. Delivery, loss, storage, and protection: Materials and equipment delivered and placed in storage stored with protection from the weather, humidity, and temperature variation, dirt, and dust or other contaminants.
- C. Coordinate deliveries with the General Contractor/Owner to ensure a timely scheduled installation.
- D. No equipment or materials are to be delivered to the job site more than three weeks prior to the commencement of its installation. Coordinate with General Contractor/Owner on location of storage materials.

3.06 SITE CONDITIONS

- A. Coordinate exact requirements governed by actual job conditions. Check information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.
- B. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City, and Utility Company.

3.07 CLEANING

- A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by electronic security work.
- B. Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current-carrying elements prior to being energized.
- C. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, dust, and construction debris and repair damaged finish, including chips, scratches, and abrasions. This includes touching up paint removed for grounding.
- D. Provide a clean work environment, free from trash/rubbish accumulated during and after cabling installation.
- E. Maintain construction materials and refuse within the area of work. Clean the work area at the end of each day.
- F. Keep liquids off finished floors, carpets, tiles, racks, and equipment. If liquid damages finishes or equipment, provide professional services to clean or repair scratched/soiled finishes or damaged equipment at the Contractors own expense.

3.08 CUTTING AND PATCHING:

- A. Make additional openings required in building construction by drilling or cutting. Use of jackhammer is specifically prohibited.
- B. Provide cutting, patching, and repairing for the proper installation and completion of the work specified in this Division by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work. This work includes but is not limited to plastering, masonry work, concrete work, carpentry work, and painting.
- C. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.

- D. Do not pierce beams, columns or structure members without approval from the Architect and structure engineer, and then only as directed.
- E. New or existing work cut or damaged shall be restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces will be repaired, refinished, and left in condition existing prior to commencement of work.

3.09 PAINTING

- A. Certain Division 27, Communications Sections contain the requirement of painting, it is the responsibility of the Contractor to coordinate the requirements and labor involved to complete this work with the General Contractor.
- B. Touch up marred and bared surfaces of primed, galvanized, and finish painted equipment, materials, and accessories installed.
- C. Restore patched surfaces as close to the original condition and finish as reasonably possible. Where patching occurs in smooth painted surface, extend final paint coat over entire unbroken surface containing patch, after patched area has received two coats of primer and two coats of finished paint

3.10 FUNCTIONAL TESTING AND DEMONSTRATION

- A. Refer to individual Division 28 Specification Sections for Additional Functional Testing and Demonstration Requirements.
- B. Test reports: Submit minimum of two weeks prior to final punch walkthrough. Maintain test equipment on-site during punch for sample proof-of-performance tests.
- C. Verify that requirements of this Specification are met. Verification through a combination of analyses, inspections, demonstrations, and tests, as described in individual Division 28 Sections.
- D. Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the Specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.
- E. Verify by formal demonstrations or tests that the requirements of this Specification have been met. Demonstrate that the electronic security systems, components, and subsystems meet specification requirements in the as-installed operating environment.
- F. Carefully plan and coordinate the final acceptance tests so that tests can be satisfactorily completed. Provide necessary instruments, labor, and materials required for tests, and including the equipment manufacturer's technical representative and qualified technicians in sufficient numbers to perform the tests within a reasonable time period.
- G. Satisfy items detailed in the final acceptance check-off list (punch list). Complete representation of specified installation requirements. At the time of final acceptance, punch list items corrected until the system is found to be acceptable to the Owner and the Project Manager.
- H. After the Contractor systems have been installed and tested, submit a completed test plan signed by the Contractor Project Manager responsible for Electronic Safety and Security and submitted for approval.

END OF SECTION 28 0500

**SECTION 28 4600
FIRE DETECTION AND ALARM**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.
- C. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.
- D. Maintenance of fire alarm system under contract for specified warranty period.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping: Materials and methods for work to be performed by this installer.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design.
- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
- D. NFPA 70 - National Electrical Code.
- E. NFPA 72 - National Fire Alarm and Signaling Code.
- F. NFPA 101 - Life Safety Code.
- G. NFPA 601 - Standard for Security Services in Fire Loss Prevention.

1.04 CONTRACTOR DESIGN

- A. The fire alarm system is Contractor designed and Contractor built.
- B. Equipment shown on the contract drawings indicates the general nature of the fire alarm system and provides coordination with the architectural design, but does not show all the components required for a complete system. Provide a complete fire alarm and communications system as needed to meet applicable codes and requirements under this section.
- C. Review various sets of drawings for initiating and notification devices, and add devices if needed to comply with the requirements of NFPA 72.
- D. Raceway, routing, and wiring for field devices are not shown on the drawings except for a few specific design requirements.
- E. The contractor-designed fire alarm system will be reviewed and approved by the authorities having jurisdiction.
- F. The contractor's shop drawing will be the design documents for the fire alarm system installation. Any changes required during construction shall be addressed and updated on the contractor's shop drawings.
- G. The Contractor-designed shop drawings will be the record drawing set at the project completion. All changes implemented during construction shall be documented, updated, and submitted as the as-built record drawing set.

1.05 SUBMITTALS

- A. See Section 28 0500 - Common Work Results for Electronic Safety and Security, for submittal procedures.
- B. Proposal Documents: Submit the following with cost/time proposal:
 - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.

2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
 3. Certification by Contractor that the system design will comply with Contract Documents.
 4. Proposed maintenance contract.
- C. Drawings must be prepared as reproducible drawings.
1. Owner will provide floor plan drawings for Contractor's use; verify all dimensions on Owner-provided drawings.
- D. Evidence of designer qualifications.
- E. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
1. Copy (if any) of list of data required by authority having jurisdiction.
 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 4. System zone boundaries and interfaces to fire safety systems.
 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 10. Detailed drawing of graphic annunciator(s).
 11. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 12. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
 13. Certification by Contractor that the system design complies with Contract Documents.
 14. Do not show existing components to be removed.
- F. Evidence of installer qualifications.
- G. Evidence of instructor qualifications; training lesson plan outline.
- H. Evidence of maintenance contractor qualifications, if different from installer.
- I. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- J. Operating and Maintenance Data: See Section 01 7800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Original copy of NFPA 72 with portions that are not relevant to this project neatly crossed out by hand; label with project name and date.
 2. Complete set of specified design documents, as approved by authority having jurisdiction.
 3. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 4. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 5. List of recommended spare parts, tools, and instruments for testing.
 6. Replacement parts list with current prices, and source of supply.

7. Detailed troubleshooting guide and large scale input/output matrix.
 8. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 9. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- K. Project Record Documents: See Section 01 7800 for additional requirements; have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- L. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
 3. Certificate of Occupancy.
 4. Maintenance contract.
 5. Report on training results.
- M. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 6000 - Product Requirements, for additional provisions.
 2. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
 3. In addition to the items in quantities indicated in PART 2, furnish the following:
 - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
 - b. One copy, on CD-ROM, of all software not resident in read-only-memory.
 - c. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

1.06 QUALITY ASSURANCE

- A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.
- B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.

2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
 4. Contract maintenance office located within 50 miles of project site.
 5. Certified in the State in which the Project is located as fire alarm installer.
- D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- E. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.
- F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 SEQUENCE OF OPERATION

- A. The system alarm operation subsequent to the alarm activation of manual station, automatic initiating device, or sprinkler flow/pressure switch is to be as follows:
1. Audible alarm indicating appliances sound a digitized tone until silenced by the alarm silence switch at the control panel.
 2. Visual alarm indicating appliances (xenon strobes) display a continuous pattern until extinguished by the alarm silence switch.
 3. Doors normally held open by door control devices release. Signal door lock systems to unlock.
 4. A supervised signal notifies an approved central station to activate.
 5. Combination fire/smoke dampers de-energizes to normally closed position.
- B. Alarm activation of elevator lobby, hoistway, or machine room smoke or heat detector in addition to the operations listed above, cause the elevator cab to be recalled according to the following sequence:
1. If the alarmed detector is on another floor other than the preferred level of egress, recall elevator cab to the preferred level of egress.
 2. If the alarmed detector is on the main egress level, the elevator cabs recalled to the predetermined alternate recall level as determined by the local authority having jurisdiction.
 3. The activation of heat detector in an elevator hoistway or machine room automatically disconnect power to the elevator motor via base-mounted contacts activating the elevator feeder shunt-trip circuit breaker. Refer to drawings.
- C. Control panel has a dedicated supervisory service indicator and a dedicated supervisory service acknowledge switch.
- D. The activation of standpipe or sprinkler valve tamper switch activates the system supervisory service audible signal and illuminates the indicator at the control panel.
1. Activating the supervisory service acknowledge switch will silence the supervisory audible signal while maintaining the supervisory serviced LED on indicating the tamper contact is still in the off-normal state.
 2. Restoring the valve to the normal position cause the supervisory service indicator to extinguish thus indicating restoration to normal position.
- E. The activation of sprinkler pre-action system pressure or low air switch activate the system supervisory service audible signal and illuminate the indicator at the control panel.
1. Activating the supervisory service acknowledge switch will silence the supervisory audible signal while maintaining the supervisory service indicator on indicating the pressure/air contact is still in the off-normal state.
 2. Restoring the air pressure to the normal causes the supervisory service indicator to extinguish thus indicating restoration to normal position.

- F. Immediately display alarm and trouble conditions on the control panel front alphanumeric display and of remote annunciators. If more alarms or troubles are in the system the operator may scroll to display new alarms.
- G. Alarm list key that will allow the operator to display alarms, troubles, and supervisory service conditions with the time of occurrence.
- H. In normal operation, fire alarm system close combination fire/smoke dampers when corresponding fan system is OFF. Fire alarm system open combination fire/smoke dampers when corresponding fan system is ON.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
- C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Alarm Control Units and Accessories:
 - 1. EST Edwards
 - 2. Provide control units made by the same manufacturer.
- B. Initiating Devices and Notification Appliances:
 - 1. Same manufacturer as control units.
 - 2. Provide initiating devices and notification appliances made by the same manufacturer, where possible.
- C. Substitutions: See Section 01 6000 - Product Requirements.
 - 1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.
 - 2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.02 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide modifications and extensions to the existing automatic fire detection and alarm system:
 - 1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
 - 2. Protected Premises: Entire building shown on drawings.
 - 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the State Fire Marshal.
 - c. The requirements of the local authority having jurisdiction .
 - d. Applicable local codes.
 - e. Contract Documents (drawings and specifications).
 - f. NFPA 101.
 - g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 - 4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.

5. Voice Notification: Provide emergency voice/alarm communications; digital.
 6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
 7. Program notification zones and voice messages as directed by Owner.
 8. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in dwelling units.
 9. Fire Alarm Control Unit: Existing, location noted on drawings.
 10. Two-Way Telephone: Provide two-way telephone service for the use of the fire service and others; provide jacks and two portable handsets.
 11. Guard's Tour: Provide guard's tour supervisory service in accordance with NFPA 601.
 12. Combined Systems: Do not combine fire alarm system with other non-fire systems.
- B. Supervising Stations and Fire Department Connections:
1. Public Fire Department Notification: Via existing system.
 2. Means of Transmission to On-Premises Supervising Station: Directly connected noncoded system.
 3. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), 2 telephone lines.
 4. Auxiliary Connection Type: Local energy.
- C. Circuits:
1. Initiating Device Circuits (IDC): Class B, Style A.
 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
 3. Notification Appliance Circuits (NAC): Class B, Style W.
- D. Spare Capacity:
1. Initiating Device Circuits: Minimum 25 percent spare capacity.
 2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
 3. Speaker Amplifiers: Minimum 25 percent spare capacity.
 4. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- E. Power Sources:
1. Primary: Dedicated branch circuits of the facility power distribution system.
 2. Secondary: Storage batteries.
 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
 4. Each Computer System: Provide uninterruptible power supply (UPS).

2.03 EXISTING COMPONENTS

- A. Existing Fire Alarm System: Remove existing components indicated and incorporate remaining components into new system, under warranty as if they were new; do not take existing portions of system out of service until new portions are fully operational, tested, and connected to existing system.
- B. Clearly label components that are "Not In Service."
- C. Remove unused existing components and materials from site and dispose of properly.

2.04 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
 1. Sprinkler water control valves.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
 1. Sprinkler water flow.
 2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.

2.05 COMPONENTS

- A. General:
 - 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 - 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.
- C. Initiating Devices:
 - 1. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
 - b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
 - 2. Manual Pull Stations:
 - a. Provide 1 extra.
 - 3. Key Operated Pull Stations:
 - a. Provide 1 extra.
 - 4. Smoke Detectors:
 - a. Provide 1 extra.
 - 5. Duct Smoke Detectors:
 - a. Provide 1 extra.
 - 6. Heat Detectors:
 - a. Provide 1 extra.
 - 7. Addressable Interface Devices:
 - a. Provide 1 extra.
 - 8. Projected Beam Type Smoke Detector.
- D. Notification Appliances:
 - 1. Speakers:
 - a. Provide 1 extra.
 - 2. Combination Horn/Strobes:
 - a. Provide 1 extra.
- E. Electromagnetic Door Holders.
- F. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.
- G. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
 - 1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
 - 2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
 - 3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.
- H. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
 - 1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 - 2. Provide one for each control unit where operations are to be performed.

3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.
- E. All components and devices shall be installed in an accessible and maintainable location.

3.02 LABELING

- A. Label alarm initiating devices with 1/2-inch by 1-inch lamicoid nameplates, indicating control panel point designation. Locate nameplates in the vicinity of the device as approved by the Owner.
- B. Provide Brady type wire markers to identify conductors at each junction or terminal. Use numbers indicated on the wiring diagrams.

3.03 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Owner will provide the services of an independent fire alarm engineer or technician to observe all tests.
- C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- D. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- E. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- F. Provide all tools, software, and supplies required to accomplish inspection and testing.
- G. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- H. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- I. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 1. Record all system operations and malfunctions.
 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
 3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.04 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 1. Hands-On Instruction: On-site, using operational system.
 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
 3. Factory Instruction: At control unit manufacturer's training facility.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
 1. Initial Training: 1 session pre-closeout.
 2. Refresher Training: 1 session post-occupancy.

- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 - 1. Initial Training: 1 session pre-closeout.
 - 2. Refresher Training: 1 session post-occupancy.
- D. Detailed Operation: Two-hour sessions for engineering staff; assume NICET level I qualifications or equivalent; combination of classroom and hands-on:
 - 1. Initial Training: 1 session pre-closeout.
 - 2. Refresher Training: 1 session post-occupancy.
- E. Maintenance Technicians: Detailed training for electrical technicians, on programming, maintaining, repairing, and modifying; factory training:
 - 1. Initial Training: One 3-day session, pre-closeout.
 - 2. Refresher Training: One 1-day session post-occupancy.
- F. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.
- G. Provide means of evaluation of trainees suitable to type of training given; report results to Owner.

3.05 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 - 5. Repeat demonstration until successful.
- B. Occupancy of the project will not occur prior to Substantial Completion.
- C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 - 1. Specified diagnostic period without malfunction has been completed.
 - 2. Approved operating and maintenance data has been delivered.
 - 3. Spare parts, extra materials, and tools have been delivered.
 - 4. All aspects of operation have been demonstrated to Owner.
 - 5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 - 6. Occupancy permit has been granted.
 - 7. Specified pre-closeout instruction is complete.
- D. Perform post-occupancy instruction within 3 months after Substantial Completion.

3.06 MAINTENANCE

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.
- C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
 - 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
 - 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.

3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- D. Provide trouble call-back service upon notification by Owner:
 1. Provide on-site response within 2 hours of notification.
 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- G. Comply with Owner's requirements for access to facility and security.

3.07 EXTRA STOCK/SPARE PARTS

- A. Provide the following equipment to be turned over to the Owner with the operation and maintenance manuals.
 1. Two photoelectric smoke detector heads.
 2. Two thermal heat detector heads.
 3. One addressable dry contact modules.
 4. Two horns.
 5. Two horns/strobes.
 6. One manual pull station.
 7. One complete set of fuses to match panel counts.

END OF SECTION 28 4600