

OUTLINE SPECIFICATION

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS - BY ESI & CITY

DIVISION 01 – GENERAL REQUIREMENTS

011000	SUMMARY
012100	ALLOWANCES
012200	UNIT PRICES
012600	CONTRACT MODIFICATION PROCEDURES
012900	PAYMENT PROCEDURES
013100	PROJECT MANAGEMENT AND COORDINATION
013200	CONSTRUCTION PROGRESS DOCUMENTATION
013233	PHOTOGRAPHIC DOCUMENTATION
013300	SUBMITTAL PROCEDURES
014000	QUALITY REQUIREMENTS
014100	REGULATORY REQUIREMENTS
014200	REFERENCES
015000	TEMPORARY FACILITIES AND CONTROLS
015639	TEMPORARY TREE AND PLANT PROTECTION
015800	TEMPORARY PROJECT SIGNAGE
*****	TEMPORARY PROJECT SIGNAGE DRAWING
016000	PRODUCT REQUIREMENTS
016100	SUBSTITUTION REQUEST FORM
017300	EXECUTION
017329	CUTTING AND PATCHING
017419	CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
017700	CLOSEOUT PROCEDURES
017836	WARRANTIES
*****	WARRANTY REPAIR REQUEST
018113.14	SUSTAINABLE DESIGN REQUIREMENTS - LEED v4 BD+C (FS 8) (ATTACHED) Supplement: LEED v4 BD+C Checklist (ATTACHED)
018113.15	BCGBCC (FS 4)
019113	GENERAL COMMISSIONING REQUIREMENTS (ATTACHED)

DIVISION 02 – EXISTING CONDITIONS

022000	ASSESSMENT
023000	SUBSURFACE INVESTIGATION
025000	SITE REMEDIATION
026000	CONTAMINATED SITE MATERIAL REMOVAL
027000	WATER REMEDIATION

DIVISION 03 – CONCRETE

031000	CONCRETE FORMING AND ACCESSORIES
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- 032000 CONCRETE REINFORCING
- 033000 CAST-IN-PLACE CONCRETE
- 034000 PRECAST CONCRETE
 - Stairs
 - FS 4 - lintels
- 036000 GROUTING
- 036000 SPECIAL CONCRETE FLOOR FINISHES
 - FGS system (flat grind seal w/ 1200 grit). – Conc-1 locations.
 - Broom and Sealed hard troweled – Conc-2 locations.
 - Concrete hardener – Conc-1 & 2 locations.
 - Petrotex oil inhibitor at apparatus bay.
 - Slip resistance certification- ADA compliance
 - L & M FGS System; RetoPlate or approved equal
- 038000 CONCRETE CUTTING AND BORING

DIVISION 04 – MASONRY

- 042200 CONCRETE UNIT MASONRY
- 042113 BRICK MASONRY
 - Mock-up panel
 - Face Brick Type
 - 3 ½” Standard Brick Veneer
 - 4” Utility Modular Brick Veneer
 - Color: Standard color
 - Grade SW
 - Type: FBX
 - Embedded Flashing
 - Ties and Seismic veneer Anchors
 - Grout
 - Color: Standard colors
 - 12” high polyethylene drainage material- CavClear Masonry Mat or approved equal
 - Plastic weep hole/vent, Cell Vent; Dur-O-Wal, Inc or approved equal
 - Mortar Pigment
 - Masonry Cleaner
 - Expansion joints- sanded
 - Masonry Sealant

DIVISION 05 – METALS

- 051000 STRUCTURAL STEEL FRAMING
- 052100 STEEL JOIST FRAMING
- 053100 STEEL DECKING
- 054000 COLD-FORMED METAL FRAMING
- 055000 METAL FABRICATIONS
 - Bay Door frames- 3/16” Galv stl bent plate wrapped at head and jamb with counter sunk screws at 2’-0” oc
 - Shelf Angles
 - Fixed Aluminum Ladder- Elevator Pit, O’Keeffe’s Inc.

Elevator Machine Beams and Divider Beams
Support Angles for Elevator Door Sills
Elevator sump with grating (with pump)
Metal Grating, galvanized finish
Pipe Bollards - galvanized and painted at meters and hydrant
Four-Fold Door Pedestal
Tube steel frame awnings
 Finish: Painted
Bollards
 8" galvanized steel, concrete filled, 6'-0" tall
Fixed Aluminum Ladder- Roof Access (one location, interior) with powder coat finish
Steel framed canopies with aluminum panel.
FS 4 – Entry and patio awning
FS 8 – Patio awning
055100 METAL STAIRS
Metal Stairs with precast concrete treads
055213 PIPE AND TUBE RAILINGS
Steel pipe handrails- painted not painted
Round Steel bar stock Guardrails – painted
Tube Steel Bar – Painted - Alternate
057000 DECORATIVE METAL
Shading devices
 Need visibility requirement.
 Use same material horizontally and vertically.
 Aluminum or prefinished steel
 McNichols or approved equal
Generator Enclosure
 Quality Perforated Metal, Square Pattern, Aluminum Type 3003-H14, .125 Gauge,
 1/2" Square on 11/16" Centers, Straight Row Hole Pattern, 53% Open Area, Mill
 Finish, Sheet, 48" Width x 120" Length
 McNichols or approved equal.
Trash Enclosure Screen
 Metal B deck

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES

061000 ROUGH CARPENTRY
 Blocking
 Plywood for backing.
064023 ARCHITECTURAL WOODWORK
Maple Laminate premium grade casework
 Medium Density Fiberboard- Industrial Grade MDF, Medite II or approved equal.
 Flush overlay
 2"Dx6"H Kick space at all cabinets - ADA
 High pressure decorative laminate
 Thermoset decorative panels; interior at concealed adjustable shelves.
 Concealed hinges
 Wire pulls
 3mm PVC edge banding
 European hinges

Stainless Steel countertops in kitchen
Solid Surface countertops with 1 ½" eased edge with 4-inch backsplash and
undermount sinks in other wet locations.
Solid Surface window sills
Hasp at sleeping room wardrobe unit
Food lockers – Hasps with owner provided padlocks

DIVISION 07 –THERMAL AND MOISTURE PROTECTION

- 071000 DAMPPROOFING AND WATERPROOFING
- 071700 BENTONITE WATERPROOFING - (ELEVATOR PIT)
CETCO; Voltex DS or approved equal.
Accessories
- 071900 WATER REPELLANTS
Water Repellents for all Exterior Concrete and Concrete Masonry Surfaces
Silane, Penetrating Water Repellant
Hydrozo, a division of ChemRex; Silane 40 or approved equal.
- 072100 THERMAL INSULATION
Building Slab
Insulfoam R-Tex VI- from top of slab to top of footing @ perimeter
2" Expanded Polystyrene
Exterior Exposed Floor (R-30)
Polyurethane Closed Cell Spray-foam Insulation
Exterior- walls (R-24)
Rockwool Rigid Insulation
Rouxel batt insulation. R4 per inch.
Sound Batt
Thermafiber SAFB – Full depth
Roof (R-38)
6" Closed Cell Polyisocyanurate - John Manville Energy 3 or approved equal
Polyethylene vapor retarder 6 mils thick (verify need)
Vapor retarder tape at all lapped joints in vapor retarder (verify need)
- 072726 FLUID APPLIED WEATHER AIR BARRIERS
Basis of Design: PROSOCO R-GUARD CAT 5, Weather and air barrier
and flashing system manufactured by PROSOCO, Inc. or an approved
equal system subject to compliance with requirements.
Joint and Seam Filler: PROSOCO R-GUARD Joint & Seam Filler
manufactured by PROSOCO, Inc. or approved equal.
Liquid Flashing: PROSOCO R-GUARD FastFlash, manufactured by
PROSOCO, Inc. or approved equal.
Air Barrier Sealant: PROSOCO R-GUARD AirDam, manufactured by
PROSOCO, Inc. or approved equal.
- 075216 BITUMINOUS ASPHALT ROOFING WITH GRANULAR CAP
(ATTACHED)
Garland or approved equal.
- 076000 FLASHING AND SHEET METAL
Flashing, Counter flashing and reglets
Pan Flashing- Door, window, Louvers 26 GA Alum with welded seams
Saddle flashing

- 076500 24 GA throughwall flashing with hemmed edge and soldered end dams
FLEXIBLE FLASHING
Grace, Vycor Butyl-25 mil. Or approved equal
Grace, Ultra Butyl-30 mil. Or approved equal
- 077200 ROOF ACCESSORIES
Tie offs for training.
- 078413 PENETRATION FIRESTOPPING
Penetration through fire resistant walls
- 078446 FIRE-RESISTIVE JOINT SYSTEMS
Sealant joints in fire resistance-rated construction
- 079200 JOINT SEALANTS
Exterior building elements
Exterior sheet metal & miscellaneous
Interior joints at moisture areas
Interior concrete floors
Interior sill plates at exterior walls
Top of GWB to framing at all exterior walls
Expansion & contraction joints
Joints between Portland cement paving and asphalt paving
Sawcuts at concrete slabs.
LEED compliant for all interior sealant

DIVISION 08 – OPENINGS

- 081113 HOLLOW METAL DOORS AND FRAMES
Exterior doors – Insulated, galvanized, factory finished, level 3 extra heavy duty
Interior doors in or adjacent to apparatus room – Insulated, galvanized, painted, level 2 heavy duty
Curries Co., Fenestra Corp., Steelcraft or approved equal
Frames – mitered or coped, continuously welded, fully insulated, solidly packed mineral-fiber insulation in frames
- 081416 FLUSH WOOD DOORS
Vancouver Door, Marshfield Door Systems, Algoma Hardwoods or approved equal
Solid core doors with wood veneer faces
Grade: Premium, extra heavy duty
Faces: Premium, WDMA grade A, Birch or White Maple, rift cut
Construction: 5 plies
Core: Agfiber
Fire rated doors, mineral core
Factory finished
FSC Certified
[FS-8 - Barn sliding door.](#)
- 083113 ACCESS DOORS AND FRAMES
Steel access panel at walls and ceilings, Stainless everywhere
Insulated at non conditioned and exterior conditions
- 083513 QUICK-RESPONSE FOUR-FOLD DOORS
[FS 4 - 14'-0" x 16'-0"](#)
[FS 8 - 14'-0" x 14'-0"](#)
2" thick minimum
Electro-mechanical operation, high-cycle doors

- R18-Polyiso
1" insulated exterior low-e (Solarban) insulated glass units, tempered
High-performance coating
Side mount
Door Engineering or approved equal
- 083613 SECTIONAL OVERHEAD DOORS
Basis of Design: Thermacore #521 Series; Overhead Door Co. or approved equal
14'x14'
1 3/4" (45 mm) thick
Trolley type operator;
72,000 cycle doors
1" insulated glass units, tempered by manufacturer.
Clear or black anodized finish
- 084113 ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS
Clear or black anodized aluminum
1" insulated exterior low-e insulated glass units, tempered.
Wide style doors with thermal break
Operable panes – Casements, awning and slider.
Kawneer Company, Inc. 451T approved equal
See schedule for location
- 086200 UNIT SKYLIGHT
Kallwall 4x4 or approved equal
Translucent 50%
- 087100 DOOR HARDWARE (ATTACHED)
- 088000 GLAZING
Glass at exterior doors and windows– Insulated, safety glass, tempered (as required by code)
Glass 1:
FS 4 – Solarban 70XL
FS 8 – Solarban 72
Glass at Interior doors and windows-Standard clear glass, single pane non-insulated, laminated or tempered as req'd.
Glass 2:
Standard clear glass, single pane non-insulated, laminated or tempered as req'd.
- 088300 MIRRORS
Framless mirrored glass panels
Mirrors at Exercise room - adhesive applied with channel
Mirrors at shower and restrooms - adhesive applied, frameless
- 089000 LOUVERS AND VENTS
Pre-finished aluminum - drainable
Ruskin, American Warming and Ventilating Inc., Construction Specialists Door or approved equal

DIVISION 09 – FINISHES

- 092900 GYPSUM BOARD
5/8" throughout
5/8" type "X" for fire resistant rated assemblies (Wall/Ceiling/elevator and under stair)
5/8" water resistant at toilet/shower areas
Impact resistant at apparatus support spaces and exercise room (*verify locations*)

Smooth finish- level 5 at living area, level 4 at support spaces
Full height Sound attenuation batts friction fit, at office, shower / restrooms, laundry room, fitness room, dorms, **training room** and mechanical room.
5/8" Glas-mat water resistant tile backer bd. full height and ceilings at mops sinks, shower, and at restroom shower stalls.
5/8" Glas-mat water resistant tile backer bd. backer units w/12" height at apparatus bay and support spaces around bay.

093000 TILING

Ceramic tile base

Ceramic tile walls

5'-0" A.F.F. at bathroom walls for wainscot.

3x12's

Provide 1/2 carton of each type and color of tile for owner.

Daltile or approve equal

095113 ACOUSTICAL PANEL CEILINGS

2'-0" x 4'-0"

Hangers -15/16" wide w/ 3/4" wall molding

Silhouette, 9/16" Bolt Slot

Seismic clip and wall clips

Edge detail - Tegular

Recycled content

Provide 100 square feet of each type of acoustical unit specied, plus 20 lineal feet of exposed suspension system components for owner.

Armstrong "Second Look" or approved equal

096513 RESILIENT BASE AND ACCESSORIES

6" resilient wall base at exercise room

Roppe Pinnacle or approved equal

096519 RESILIENT RUBBER FLOORING (AT ELEVATOR)

"NoraPlan Mega"

Nora Rubber Flooring, Freudenberg Building Systems, Inc. or approved equal

096566 RESILIENT ATHLETIC FLOORING

3/8" Thick

Transition strips

Adhesives, Sealer, Cleaner

TufFlex Force by Flexco a division of Roppe, Inc. or approved equal

098000 ACOUSTIC TREATMENT (FS 8)

4x8 1" Thick at bottom side of deck

Sound black acoustic boards

099113 EXTERIOR PAINTING

Eggshell, Semigloss

High performance Acrylic or Epoxy for field finished metal surfaces

Sherwin - Williams Co., Parker Paint Co., Rodda Paint Co or approved equal

099123 INTERIOR PAINTING

Eggshell, Semigloss

High performance Acrylic or Epoxy for field finished metal surfaces

Epoxy paint at interior bathrooms

Epoxy paint at all support spaces and apparatus bay

LEED compliant VOC limits

Provide 1 gallon of each color for owner.

Sherwin - Williams Co., Parker Paint Co., Rodda Paint Co or approved equal

DIVISION 10 – SPECIALTIES

101100 VISUAL DISPLAY SURFACES

White Board
Tack Boards
Clairidge or approved equal

101400 SIGNAGE

Exterior building signage
Building address
Striping and pavement markings
Dedication Plaque
LEED Plaque
FS 4 – BCGBC Plaque
FS 8 – LEED Plaque

102600 WALL AND DOOR PROTECTION

Rub Rails at beds
Stainless Steel Corner Guards
height. 7'-0"
IPC Door and Wall protection systems. Inpro corporations or approved equal

102800 TOILET, BATH AND LAUNDRY ACCESSORIES

Toilet tissue dispensers – surface mount, multi roll
Recess seat cover dispenser (In public restrooms only)
Automatic hand dryer (In public restrooms only)
Grab bars, concealed mounting 42" x 54" 'L' 18" vert bar Shower grab bars
Robe hooks – double
Paper towel dispenser-wall mounted
Trash/Recycle Receptacle- Freestanding
Shower rod- (for ADA showers)
Shower curtain
Shower curtain hooks
Handicapped folding shower seat
Soap dispensers (Owner provided owner installed)
Sanitary Napkin Dispenser (In public restrooms only)
Mop holders
Shelf
Bobrick Washroom Equipment or approved equal

104400 FIRE PROTECTION SPECIALTIES

Cabinet
Recessed and Semi recessed, rolled edge
Aluminum
Tempered glazing
Extinguishers – by Boise City
JL Industries, Larsen's Manufacturing Co. or approved equal.

107500 FLAGPOLES

Internal halyard system, full hardware for 1 flag
Aluminum 35'-0" height, .188" wall, 7" base
Ground mounted pole
LED halyard and flag beacon
Flagpole Warehouse or approved equal

- 109000 MISCELLANEOUS SPECIALTIES
- Stainless steel shelf
 - 18-8 type 304-16ga with satin finish
 - Brass Fire Pole:
 - McIntire Brass Works, Inc., Model 19 or approved equal
 - Pole: 1/2 inch diameter, 5/32 inch wall diameter, cold drawn brass.
 - Wall Braces: Brass "Flush Tee" mounting system for side mount wall brace application Brassfinders or approved equal.
 - Landing Mat: 2 inches thick, 36-inch diameter minimum (32 inches is standard), Closed Cell Neoprene.
 - GearGrid or approved equal; Bunker gear storage racks
 - 24"x 20"x72"H
 - (1) Heavy Hangers in each unit
 - (1) Gear Dryer in each unit
 - (1) Gearglove in each unit
 - Top-side Storage for each unit
 - FS 4 – 27 Total
 - FS 8 – 12 Total
 - 80" TV (owner provided contractor installed)
 - Metal Shelving
 - Wall mount Eyewash

DIVISION 11 – EQUIPMENT

- 110513 COMMON MOTOR REQUIREMENTS FOR EQUIPMENT
- 113100 APPLIANCES
- (1) Cooktop (O.P.C.I.)
 - (1) Wall Ovens with automatic relight feature (O.P.C.I.)
 - (1) Vent hood w/ 900 CFM internal blower, flue extension (mounting height and edge-head bump issue) (O.P.C.I.)
 - (1) Clothes Washer (O.P.C.I.)
 - (1) Clothes Dryer (O.P.C.I.)
 - (3) Side by side stainless Refrigerator/Freezers with Water & Ice Maker (O.P.C.I.)
 - (1) Dishwasher (O.P.C.I.)
 - (2) Microwave Oven, with trim Kit (O.P.C.I.)
 - (1) Plumbed coffee maker with double burner (O.P.C.I.)
 - (1) Ice Maker (O.P.C.I.)

DIVISION 12 – FURNISHINGS

- 122413 ROLLER SHADES
- Roller shades, manual operation
 - Blackout shades at sleeping rooms
 - Mecho or approved equal
- 124816 FLOOR GRILLES
- Aluminum
 - Tread Rails: Extruded-aluminum tread rails.
 - Tread Rail Spacing: 1-1/2 inches (38 mm) o.c. with 1/8- to 3/16-inch- (3.2- to 4.8-mm-) wide openings between treads.
 - Top Surface: Aluminum-oxide or silicon-carbide grit in epoxy matrix,

Abrasive particles bonded to or imbedded in vinyl insert, Fusion-bonded, level-cut-pile nylon carpet insert; 1/4 inch (6.4 mm) high, 28 oz./sq. yd. (950 g/sq. m).
Top Surface Color: As selected by Architect from manufacturer's full range of industry colors.
Grille Size: As indicated, see floor plans.
Mats Incorporated or approved equal

DIVISION 14 – CONVEYING EQUIPMENT

142400 HYDRAULIC ELEVATOR
 ThyssenKrupp, Otis or approved equal.

DIVISION 21 – FIRE SUPPRESSION

210000 FIRE SPRINKLER SYSTEM (ATTACHED)

DIVISION 22 – PLUMBING

220000 PLUMBING GENERAL REQUIREMENTS (ATTACHED)
220100 PLUMBING (ATTACHED)

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

230000 HVAC GENERAL REQUIREMENTS (ATTACHED)
230100 HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)
 (ATTACHED)
230800 COMMISSIONING OF HVAC (ATTACHED)
230900 DIRECT DIGITAL CONTROLS (ATTACHED)

DIVISION 26 – ELECTRICAL

260500 ELECTRICAL GENERAL PROVISIONS (ATTACHED)
260501 FIELD TEST AND OPERATIONAL CHECK (ATTACHED)
260519 CONDUCTORS AND CABLES (ATTACHED)
260526 GROUNDING (ATTACHED)
260529 SUPPORTING DEVICES (ATTACHED)
260533 RACEWAYS AND BOXES (ATTACHED)
260800 ELECTRICAL COMMISSIONING REQUIREMENTS (ATTACHED)
260923 LIGHTING CONTROL DEVICES (ATTACHED)
262416 PANELBOARDS (ATTACHED)
262418 MOTOR STARTERS (ATTACHED)
262726 WIRING DEVICES (ATTACHED)
262813 FUSES (ATTACHED)
262815 DISCONNECT SWITCHES (ATTACHED)

263213 PACKAGED ENGINE GENERATORS AND TRANSFER SWITCHES
(ATTACHED)

264314 TRANSIENT VOLTAGE SURGE SUPPRESSION (ATTACHED)

265100 INTERIOR LIGHTING (ATTACHED)

265600 EXTERIOR LIGHTING (ATTACHED)

DIVISION 27 – COMMUNICATIONS

271101 TELECOM RACEWAY SYSTEMS (ATTACHED)

275116 PUBLIC ADDRESS SYSTEM (ATTACHED)

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

283100 FIRE ALARM (ATTACHED)

DIVISION 31 – EARTHWORK

310120 TRAFFIC CONTROL (ATTACHED)

311000 SITE CLEARING (ATTACHED)

312000 EARTH MOVING (ATTACHED)

DIVISION 32 – EXTERIOR IMPROVEMENTS

321216 ASPHALT PAVING (ATTACHED)

321313 CONCRETE PAVING (ATTACHED)

321400 CONCRETE UNIT PAVERS (ATTACHED)

321713 PARKING BUMPERS (ATTACHED)

323113 CHAIN LINK FENCES AND GATES (ATTACHED)

323150 SITE SIGNAGE (ATTACHED)

323180 SITE FURNISHINGS (ATTACHED)

323190 FLAGPOLE (ATTACHED)

328400 LANDSCAPE IRRIGATION (ATTACHED)

328500 LANDSCAPE GRADING (ATTACHED)

329200 TURF AND GRASSES (ATTACHED)

FS 4 – No Turf

FS 8 – Dry lay seed.

329300 PLANTS (ATTACHED)

DIVISION 33 – UTILITIES

331100 SITE WATER LINES (ATTACHED)

333100 SITE SANITARY SEWERAGE SYSTEM (ATTACHED)

3341 00 STORM UTILITY DRAINAGE AND PIPING (ATTACHED)

BOISE CITY FIRE STATION #4 & 8
BOISE, IDAHO

FEBRUARY, 2016

334600 SUBDRAINAGE (ATTACHED)

END OF SECTION

Exhibit “A”

CM/GC Bid & Procurement Management Plan

1. CM/GC Prepares Bid Package Status Report (BPSR)
 - a. Identifies Bid Package Breakdown
 - b. Identifies Bid and Award Cycle Target Dates for Individual Bid Packages
 - c. Identifies Self-Perform Bidding
2. CM/GC Contractor Identifies Potential Qualified Bidders
 - a. Generate Preliminary Bidders List
3. CM/GC Contractor Registers Qualified Bidders
 - a. Bidder’s Registration Form
 - i. General Information (Contact information, Business Type, Confirm Licensing information, Date of Incorporation, Etc.)
 - ii. Bid Package Identification (Select Bid/Procurement Packages of Interest)
 - iii. Experience With Similar Work (List 3-Projects of Similar Size and Scope)
 - iv. Resource Capabilities (List Available Manpower and Applicable Equipment to Perform Scope of Work)
 - v. Backlog (List Backlog of Future Work During Respective Scope of Work)
 - vi. Bonding Capacity (List Bonding Capacity)
 - vii. Safety Information (Current E-Mod, List OSHA Violations within the Last 5-Years)
 - viii. Insurance Information (Affidavit of Insurance Compliance)
 - b. Register Three (3) Qualified Bidders Minimum, or Maximum Number of Bidders Available, for Each Respective Scope of Work
 - c. Submit Proposed Bidders List to City of Boise for Review
4. CM/GC Sets up Proprietary E-Mail Address for Receiving Sealed Bids,
5. CM/GC shall send self- performed bid packages to City of Boise at least 3 hours before bids are a due to CM/GC. City representative will bring sealed bid to opening.
6. Issue Bid Packages per CM/GC Final Bidder List – Begin Bid Cycle
7. CM/GC Hosts Pre-Bid Meeting (Include Team)
 - a. Distribute Agenda
 - i. Project Overview
 - ii. Bidder Requirements (5 % bid security, no conditional bids, sealed bids, etc)
 - iii. Schedule Review
 - iv. Site Logistics and Specifics
 - v. Project Clerical Processes
 - vi. Bidder Q&A

8. Receive Pre-Bid Requests for Information (RFI's) and Issue Addenda and Bid Clarifications(have City Project Manager review)
9. **Bid Opening at CM/GC Office in Presence of Owner – Complete Bid Cycle**
(At opening make sure bid is signed and bid security included, City opens self-perform bids at bid opening)
 - a. Preliminary Evaluation of Bids for Responsiveness and Completeness
 - b. Prepare Preliminary Bid Tabulation Results
 - c. Identify Apparent Low Bidder
10. CM/GC Analyzes Bids for Accuracy and Completeness per Bid Requirements
 - a. Interview Bidders
 - b. Prepare Final Bid Tabulation Results
11. CM/GC Issues Final Bid Tabulation Results to City of Boise
12. CM/GC Issues Notice of Intent to Lowest Responsible Bidder

SECTION 018113.14 - SUSTAINABLE DESIGN REQUIREMENTS - LEED v4 BD+C

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements and procedures for compliance with certain prerequisites and credits needed for Project to obtain "LEED Version 4 for Building Design and Construction" (LEED v4 BD+C) **Gold** certification based on USGBC's LEED v4 BD+C.
 - 1. Specific requirements for LEED are also included in other Sections.
 - 2. Some LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
 - 3. A copy of the LEED Project checklist is attached at the end of this Section for information only.
 - a. Some LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.

1.3 DEFINITIONS

- A. LEED: USGBC's "LEED Version 4 for Building Design and Construction."
 - 1. Definitions that are a part of "LEED Version 4 for Building Design and Construction" (LEED v4 BD+C) apply to this Section.
- B. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001. Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
- C. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

- D. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
 - 1. "Postconsumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
 - 2. "Preconsumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials, such as rework, regrind, or scrap, generated in a process and capable of being reclaimed within the same process that generated it.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **Project site**. Review LEED requirements and action plans for meeting requirements.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Respond to questions and requests from Architect and the USGBC regarding LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until the USGBC has made its determination on the Project's LEED certification application. Document responses as informational submittals.
- B. Submit documentation to USGBC and respond to questions and requests from USGBC regarding LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until the USGBC has made its determination on the Project's LEED certification application.
 - 1. Document correspondence with USGBC as informational submittals.

1.6 ACTION SUBMITTALS

- A. General: Submit additional sustainable design submittals required by other Specification Sections.
- B. Sustainable design submittals are in addition to other submittals.
 - 1. If submitted item is identical to that submitted to comply with other requirements, include an additional copy with other submittal as a record copy of compliance with indicated LEED requirements instead of separate sustainable design submittal. Mark additional copy "Sustainable design submittal."
- C. Sustainable Design Documentation Submittals:
 - 1. Environmental Product Declarations complying with LEED requirements.

2. Documentation complying with Section 017419 "Construction Waste Management and Disposal."
3. Product data for adhesives and sealants used inside the weatherproofing system, indicating VOC content and laboratory test reports showing compliance with requirements for low-emitting materials.
4. Product data for paints and coatings used inside the weatherproofing system, indicating VOC content and laboratory test reports showing compliance with requirements for low-emitting materials.
5. Laboratory test reports for flooring, indicating compliance with requirements for low-emitting materials.
6. Laboratory test reports for products containing composite wood or agrifiber products or wood glues, indicating compliance with requirements for low-emitting materials.
7. Laboratory test reports for ceilings, walls, and thermal insulation, indicating compliance with requirements for low-emitting materials.
8. Construction Indoor-Air-Quality (IAQ) Management:
 - a. Construction IAQ management plan.
 - b. Product data for temporary filtration media.
 - c. Product data for filtration media used during occupancy.
 - d. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.
9. IAQ Assessment:
 - a. Signed statement describing the building air flush-out procedures, including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
 - b. Product data for filtration media used during flush-out and occupancy.
 - c. Report from testing and inspecting agency indicating results of IAQ testing and documentation showing compliance with IAQ testing procedures and requirements.
10. Soil erosion and sedimentation control plan complying with LEED requirements. Plan based on 2012 U.S. Environmental Protection Agency Construction General Permit or local equivalent, whichever is more stringent."

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For LEED coordinator.
- B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
 1. Plumbing.
 2. Mechanical.
 3. Electrical.
 4. Specialty items, such as elevators and equipment.

- C. Sustainable Design Action Plans: Provide preliminary submittals within **14** days of date established for **the Notice to Proceed**, indicating how the following requirements will be met:
 - 1. List of proposed products with Environmental Product Declarations.
 - 2. Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
 - 3. Construction IAQ management plan.
- D. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with sustainable design action plans.

1.8 QUALITY ASSURANCE

- A. LEED Coordinator: Engage an experienced LEED-accredited professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to these LEED credits, the Contractor shall provide additional materials and procedures necessary to obtain LEED credits indicated.

2.2 LOW-EMITTING MATERIALS

- A. Paints and Coatings: For field applications **that are inside the weatherproofing system**, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Nonflat Paints and Coatings: 50 g/L.
 - 3. Dry-Fog Coatings: 150 g/L.
 - 4. Primers, Sealers, and Undercoaters: 100 g/L.
 - 5. Rust-Preventive Coatings: 100 g/L.
 - 6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
 - 7. Pretreatment Wash Primers: 420 g/L.
 - 8. Clear Wood Finishes, Varnishes: 275 g/L.
 - 9. Clear Wood Finishes, Lacquers: 275 g/L.
 - 10. Floor Coatings: 50 g/L.
 - 11. Shellacs, Clear: 730 g/L.
 - 12. Shellacs, Pigmented: 550 g/L.
 - 13. Stains: 100 g/L.

- B. Paints and Coatings: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Adhesives and Sealants: For field applications **that are inside the weatherproofing system**, adhesives and sealants shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
1. Wood Glues: 30 g/L.
 2. Metal-to-Metal Adhesives: 30 g/L.
 3. Adhesives for Porous Materials (Except Wood): 50 g/L.
 4. Subfloor Adhesives: 50 g/L.
 5. Plastic Foam Adhesives: 50 g/L.
 6. Carpet Adhesives: 50 g/L.
 7. Carpet Pad Adhesives: 50 g/L.
 8. VCT and Asphalt Tile Adhesives: 50 g/L.
 9. Cove Base Adhesives: 50 g/L.
 10. Gypsum Board and Panel Adhesives: 50 g/L.
 11. Rubber Floor Adhesives: 60 g/L.
 12. Ceramic Tile Adhesives: 65 g/L.
 13. Multipurpose Construction Adhesives: 70 g/L.
 14. Fiberglass Adhesives: 80 g/L.
 15. Contact Adhesives: 80 g/L.
 16. Structural Glazing Adhesives: 100 g/L.
 17. Wood Flooring Adhesives: 100 g/L.
 18. Structural Wood Member Adhesives: 140 g/L.
 19. Single-Ply Roof Membrane Adhesives: 250 g/L.
 20. Special-Purpose Contact Adhesives (That Are Used to Bond Melamine-Covered Board, Metal, Unsupported Vinyl, Rubber, or Wood Veneer 1/16 Inch or Less in Thickness to Any Surface): 250 g/L.
 21. Top and Trim Adhesives: 250 g/L.
 22. Plastic Cement Welding Compounds: 250 g/L.
 23. ABS Welding Compounds: 325 g/L.
 24. CPVC Welding Compounds: 490 g/L.
 25. PVC Welding Compounds: 510 g/L.
 26. Adhesive Primer for Plastic: 550 g/L.
 27. Sheet-Applied Rubber Lining Adhesives: 850 g/L.
 28. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
 29. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
 30. Special-Purpose Aerosol Adhesives (All Types): 70 percent by weight.
 31. Other Adhesives: 250 g/L.
 32. Architectural Sealants: 250 g/L.
 33. Nonmembrane Roof Sealants: 300 g/L.
 34. Single-Ply Roof Membrane Sealants: 450 g/L.
 35. Other Sealants: 420 g/L.
 36. Sealant Primers for Nonporous Substrates: 250 g/L.
 37. Sealant Primers for Porous Substrates: 775 g/L.
 38. Modified Bituminous Sealant Primers: 500 g/L.
 39. Other Sealant Primers: 750 g/L.

- D. Adhesives and Sealants: For field applications that are inside the weatherproofing system, 90 percent of adhesives and sealants shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Flooring: Flooring shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. Composite Wood: Composite wood, agrifiber products, and adhesives shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
- G. Ceilings, Walls, and Thermal Insulation: Ceilings, walls, and thermal insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 NONSMOKING BUILDING

- A. Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.

3.2 CONSTRUCTION WASTE MANAGEMENT

- A. Comply with Section 017419 "Construction Waste Management and Disposal."

3.3 CONSTRUCTION IAQ MANAGEMENT

- A. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."
 - 1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 015000 "Temporary Facilities and Controls," install MERV 8 filter media at each return-air inlet for the air-handling system used during construction.
 - 2. Replace air filters immediately prior to occupancy.

3.4 IAQ ASSESSMENT

- A. Flush-Out:
 - 1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14,000 cu. ft. (4 300 000 L)

of outdoor air per **sq. ft. (sq. m)** of floor area while maintaining an internal temperature of at least **60 deg F (16 deg C)** and a relative humidity no higher than 60 percent.

2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of **3500 cu. ft. (1 070 000 L)** of outdoor air per **sq. ft. (sq. m)** of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of **0.30 cfm per sq. ft. (1.52 L/s per sq. m)** of outside air or the design minimum outside-air rate, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of **14,000 cu. ft./sq. ft. (4 300 000 L/sq. m)** of outside air has been delivered to the space.

B. Air-Quality Testing: **Owner will engage** testing agency to perform the following:

1. Conduct baseline IAQ testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "LEED Reference Guide for Building Design and Construction."
2. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
 - a. Formaldehyde: 27 ppb.
 - b. Particulates (PM10): 50 micrograms/cu. m.
 - c. Ozone: 0.075 ppm, according to ASTM D 5149.
 - d. Total Volatile Organic Compounds: 500 micrograms/cu. m.
 - e. 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
 - f. Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
 - g. Target Chemicals in California Department of Public Health "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Table 4-1 (except formaldehyde): Allowable concentrations in California Department of Public Health "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Table 4-1.
3. For each sampling point where the maximum concentration limits are exceeded, take corrective action until requirements have been met.
4. Air-sample testing shall be conducted as follows:
 - a. All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside-air flow rate for the occupied mode throughout the duration of the air testing.
 - b. Building shall have all interior finishes installed, including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings, such as workstations and partitions, are encouraged, but not required, to be in place for the testing.
 - c. Number of sampling locations varies depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per **5000 sq. ft. (465 sq. m)**. **For large open spaces, one sampling point per 50,000 sq. ft. (4654 sq. m) may be used.**

- d. Air samples shall be collected between 3 and 6 feet (900 and 1800 mm) from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION 018113.14

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Commissioning: Commissioning is a systematic process of ensuring and documenting that all building systems perform interactively according to the design intent and the owner's operational needs. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training.
- B. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
 - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
 - 2. Verify and document proper performance of equipment and systems.
 - 3. Verify that O&M documentation left on site is complete.
 - 4. Verify that the Owner's operating personnel are adequately trained.
- C. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

1.2 COORDINATION

- A. Commissioning Team: The members of the commissioning team consist of the Commissioning Authority (CxA), the owner's designated Project Manager (PM), the General Contractor (GC or Contractor), the architect and design engineers, the Plumbing Contractor (PC), the Mechanical Contractor (MC), the Electrical Contractor (EC), the TAB representative, the Controls Contractor (CC), any other installing subcontractors or suppliers of equipment. If known, the Owner's building or plant operator/engineer is also a member of the commissioning team.
- B. Management: The CxA is hired by the Owner directly. The CxA directs and coordinates the commissioning activities. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. The CxA's responsibilities are the same regardless of who hired the CxA.
- C. Scheduling: The CxA will work with the GC according to established protocols to schedule the commissioning activities. The CxA will provide sufficient notice to the PM and GC for scheduling commissioning activities. The GC will integrate all commissioning activities into the master schedule. All parties will address scheduling on an ongoing basis and make necessary notifications in a timely manner in order to expedite the commissioning process.

1.3 COMMISSIONING PROCESS

- A. Commissioning Process: The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
 - 1. Commissioning during construction begins with a scoping meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.
 - 2. Additional meetings will be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
 - 3. Equipment documentation is submitted to the CxA during normal submittals, including detailed start-up procedures.
 - 4. The CxA works with the Subs to develop startup plans and startup documentation formats, which may include providing the Subs with prefunctional checklists to be completed during the startup process.

5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with prefunctional checklists being completed before functional testing.
6. The Subs, under their own direction, execute and document the prefunctional checklists and perform startup and initial checkout. The CxA documents that the checklists and startup were completed according to approved plans, and may witness startup of selected systems and equipment.
7. The CxA develops specific equipment and system functional testing procedures. The Subs review the procedures.
8. The procedures are executed and documented by the CxA, with the assistance of the Subs as necessary.
9. Items of non-compliance in material, installation, programming, calibration, start-up or setup are corrected at the Sub's expense and the system retested.
10. The CxA reviews O&M's for all commissioned systems for completeness.
11. The CxA reviews and approves training plans/agenda for training provided by the Subs (for commissioned equipment), and verifies that training was completed as per the contract documents.
12. The CxA issues report of commissioning process and results.
13. The CxA performs a Near-Warranty End or Post Occupancy Review approximately 10 months into the 12 month warranty period.

1.4 RELATED WORK

- A. Specific commissioning requirements are given in the following sections of these specifications. All of the following sections apply to the Work of this section.
 1. Section 019113 - Gen. Commissioning Requirements: Describes the commissioning process, responsibilities common to all parties, responsibilities of the A/E, CxA, PM, GC and Suppliers, focusing on the CxA. The unique PC, MC, CC, EC, and TAB responsibilities are included in Divs. 22, 23 & 26 under the following sections.
 2. Section 230800 - Commissioning of HVAC: Describes the Cx responsibilities of the mechanical, controls and TAB contractors and the prefunctional testing and startup responsibilities of each.
 3. Section 260800 - Cx of Electrical Systems: Describes the Cx responsibilities of the electrical contractor and their prefunctional testing and startup responsibilities.
 4. Section 230000 – HVAC General Requirements: Alerts the mechanical contractor to Cx responsibilities in 230800.
 5. Section 230900 – Direct Digital Controls: Lists special requirements and alerts the controls contractor of the special requirements of the control contractor and control system in 2308 00.
 6. Section 260500 – Electrical General Provisions: Alerts the electrical contractor to Cx responsibilities in 260800.

1.5 RESPONSIBILITIES

- A. The responsibilities of various parties in the commissioning process are provided in this section. It is noted that the services for the Commissioning Authority, Project Manager, Construction Manager, Architect, and HVAC mechanical and electrical designers/engineers are not provided for in this contract. That is, the Contractor is not responsible for providing their services. Their responsibilities are listed here to clarify the commissioning process.
- B. All Parties
 1. Follow the Commissioning Plan and Cx Specification requirements.
 2. Attend commissioning scoping meeting and additional meetings, as necessary.

C. Architect (of the A/E)

1. Document and update as required the Owner's Project Requirements (OPR).
2. Attend the commissioning scoping meeting and selected commissioning team meetings.
3. Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted.
4. Provide any design narrative documentation requested by the CxA.
5. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
6. Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.
7. Coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning.

D. Mechanical and Electrical Designers/Engineers (of the A/E)

1. Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted.
2. Update final basis of design documentation for inclusion in the Systems Manual.
3. The designers shall assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
4. Attend commissioning scoping meetings and other selected commissioning team meetings.
5. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
6. Provide one-line system diagrams to the CxA for use in preparing the Systems Manual.
7. Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.
8. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.

E. Commissioning Authority (CxA)

1. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving, non-conformance or deficiencies, but ultimately that responsibility resides with the general contractor and the A/E. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. The Contractors will provide all tools or the use of tools to start, check-out and functionally test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the CxA.
2. The CxA will provide information to the US Green Building Council web site in support of satisfying the LEED Energy and Atmosphere (EA) prerequisite 1, Fundamental Commissioning of Building Energy Systems; and EA credit 3, Enhanced Commissioning. The CxA is not the LEED Coordinator for the project.
3. Coordinate the commissioning work and, with the GC and PM, ensure that commissioning activities are being scheduled into the master schedule.
4. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
5. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.

6. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
7. Review and approve normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
8. Write and distribute pre-functional tests and checklists.
9. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
10. Approve systems startup by reviewing start-up reports and by selected site observation.
11. Oversee sufficient functional testing of the control system and approve it to be used for TAB, before TAB is executed.
12. With necessary assistance and review from installing contractors, write the functional testing procedures for equipment and systems. This may include energy management control system trending, stand-alone data logger monitoring or manual functional testing. Submit to PM for review, and for approval if required.
13. Analyze any functional performance trend logs and monitoring data to verify performance.
14. Coordinate, witness and approve manual functional testing performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
15. Perform or witness functional test procedures on the commissioned equipment.
16. Maintain a master deficiency and resolution log and a separate testing record. Provide the PM with written progress reports and test results with recommended actions.
17. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
18. Oversee and approve the training of the Owner's operating personnel on commissioned systems.
19. Review and approve the preparation of the O&M manuals for commissioned systems.
20. Provide a Systems Manual for all commissioned systems.
21. Provide a final commissioning report (as described in this section).
22. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.
23. Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in resolving outstanding problems.

F. Owner's Project Manager (PM)

1. Manage the contract of the A/E and of the GC.
2. Provide final approval for the completion of the commissioning work.
3. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.

G. General Contractor (GC)

1. Facilitate the coordination of the commissioning work by the CxA, and with the CxA ensure that commissioning activities are being scheduled into the master schedule.
2. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.

3. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.
4. Ensure that all Subs execute their commissioning responsibilities according to the Contract Documents and schedule.
5. A representative shall attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
6. Coordinate the training of owner personnel.
7. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
8. Ensure that Subs correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

H. Equipment Suppliers

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
2. Assist in equipment testing per agreements with Subs.
3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data logging equipment that may be used by the CxA.
4. Through the contractors they supply products to, analyze specified products and verify that the designer has specified the newest most updated equipment reasonable for this project's scope and budget.
5. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
6. Review test procedures for equipment installed by factory representatives.

1.6 SYSTEMS TO BE COMMISSIONED

A. The following equipment and associated systems will be commissioned in this project:

1. HVAC Systems
 - a. Packaged VAV Rooftop Air Handling Units
 - b. Variable Refrigerant Systems
 - c. Exhaust Fans
 - d. Split System Fan Coil Units
 - e. Heat Recovery Units
 - f. Radiant & Electric Heaters
 - g. Evaporative Coolers
2. New DDC HVAC Building Automation System
3. Electrical Systems & Equipment
 - a. Lighting / Day-lighting Control Systems (occupancy sensors, photocells, etc...)
 - b. Electrical Sub-metering (interface with Building Automation System)
 - c. Emergency Generator System
 - d. Fire Alarm System Interaction with HVAC and HVAC Controls Systems
4. Plumbing Systems

- a. Electric Water Heaters
 - b. Sensor faucets / flush valves
 - c. Domestic Hot Water Recirculation System (pumps, mixing valves, etc...)
5. Specialty Systems
- a. Food service alarm interlocks
 - b. Automatic doors
 - c. Carbon Monoxide monitoring/alarms

B. General references to equipment will refer to the above systems and their components.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required functional testing shall be provided by the Division contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC system and controls system in Division 23, except for equipment specific to and used by the TAB contractor in their commissioning responsibilities.
- B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site, except for stand-alone data-logging equipment that may be used by the CxA.
- C. Data-logging equipment and software required to test equipment will be provided by the CxA for use by the CxA only, and shall not become the property of the Owner.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the *Specifications*. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of $\pm 0.5^{\circ}\text{F}$ and a resolution of $\pm 0.2^{\circ}\text{F}$. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 MEETINGS

- A. Scoping Meeting: Within 60 days of commencement of construction, the CxA will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Information gathered from this meeting will be used by the CxA to revise the Draft Commissioning Plan to its "final" version.
- B. Miscellaneous Meetings: CxA may attend regular construction meetings to keep informed of project progress & coordinate the commissioning activities. Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Subs. The CxA will plan these meetings and will minimize unnecessary time being spent by Subs.

3.2 REPORTING

- A. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.
- B. A final summary report (about four to six pages, not including backup documentation) by the CxA will be provided to the PM, focusing on evaluating commissioning process issues and identifying areas where the process could be

improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report.

3.3 SUBMITTALS

- A. The CxA will provide appropriate contractors with a specific request for the type of submittal documentation the CxA requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority. All documentation requested by the CxA will be included by the Subs in their O&M manual contributions.
- B. The CxA may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.
- C. The Commissioning authority will review and approve submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications, which is the A/E's responsibility. The Commissioning authority will notify the GC, PM or A/E as requested, of items missing or areas that are not in conformance with Contract Documents and which requires resubmission.
- D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CxA will review and approve them.

3.4 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment to be commissioned, according to Section 1.06, Systems to be Commissioned.
- B. General: Prefunctional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional testing of equipment or subsystems of the given system.
- C. Start-up and Initial Checkout Plan: The CxA shall assist the contractor in developing pre-functional checklists and a detailed start-up plan for all commissioned equipment. The primary role of the CxA in this process is ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.
 - 1. The subcontractor responsible for the purchase of the equipment develops the full start-up plan. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
 - 2. The full start-up plan could consist of something as simple as:
 - a. The CxA's, contractor's or manufacturer's prefunctional checklists.
 - b. The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
 - c. The manufacturer's normally used field checkout sheets.
 - 3. The subcontractor submits the full startup plan to the CxA for review and approval.
 - 4. The CxA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.

5. The full start-up procedures and the approval form may be provided to the PM for review and approval, depending on management protocol.

D. Execution of Prefunctional Checklists and Startup.

1. Four weeks prior to startup, the Subs and vendors schedule startup and checkout with the PM, GC and CxA. The performance of the prefunctional checklists, startup and checkout are directed and executed by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.
2. The CxA shall verify compliance on at least 20% of equipment requiring formal start-up procedures.
3. The Subs and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and prefunctional tests and checklists.
4. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

E. Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Subs shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.
2. The CxA reviews the report and submits either a non-compliance report or an approval form to the Sub or PM. The CxA shall work with the Subs and vendors to correct and retest deficiencies or uncompleted items. The CxA will involve the PM, GC and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA recommends approval of the execution of the checklists and startup of each system to the PM using a standard form.
3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back-charges to the responsible party. Refer to Part 3.6 herein for details.

3.5 FUNCTIONAL TESTING

- A. This sub-section applies to all commissioning functional testing for all divisions.
- B. The general list of equipment to be commissioned is found in Section 019113, Part 1.6.
- C. Objectives and Scope: The objective of functional testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required.

- D. Development of Test Procedures: Before test procedures are written, the CxA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub or vendor shall provide limited assistance to the CxA in developing the procedures (answering questions about equipment, operation, sequences, etc.). Prior to execution, the CxA shall provide a copy of the test procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection. The CxA may submit the tests to the A/E for review, if requested.
- E. Test Methods

1. Functional testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data-loggers.
2. Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Overwritten Values: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair dryer rather than overwriting the value or by altering the appropriate set point to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
4. Altering Set Points: Rather than overwriting sensor values, and when simulating conditions is difficult, altering set points to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout set point to be 2F above the current outside air temperature.
5. Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during prefunctional testing.
6. Setup: Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. At completion of the test, the CxA shall return all affected building equipment and systems, due to temporary modifications, to their pre-test condition.
7. Sampling
 - a. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. It is noted that no sampling by Subs is allowed in prefunctional checklist execution.
 - b. A common sampling strategy is the "xx% Sampling—yy% Failure Rule", defined by the following example.
 - 1) xx = the percent of the group of identical equipment to be included in each sample.
 - 2) yy = the percent of the sample that if failing, will require another sample to be tested.
 - 3) The example below describes a 20% Sampling—10% Failure Rule.
 - i Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the "first sample."
 - ii If 10% (yy) of the units in the first sample fail the functional testings, test another 20% of the group (the second sample).
 - iii If 10% of the units in the second sample fail, test all remaining units in the whole group.
 - iv If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.

F. Coordination and Scheduling.

1. The Subs shall provide sufficient notice to the CxA regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The Controls Contractor will provide written notification that they have completed all required prefunctional checklists, point-to-point verification, sensor calibration

verification, programming verification checks, and that their system(s) are complete and ready for functional testing before testing will proceed. The CxA will schedule functional tests through the PM, GC and affected Subs. The CxA shall develop, execute and document the functional testing of all equipment and systems.

2. In general, functional testing is conducted after prefunctional testing and startup has been satisfactorily completed. The control system is complete and pre-functionally tested before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

G. Test Equipment: Refer to Section 019113, Part 2 for test equipment requirements.

H. Problem Solving: The CxA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the GC, Subs and A/E.

3.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation: The CxA shall document the results of all functional testing using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the PM for review and approval and to the Subs for review.

B. Non-Conformance

1. The CxA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the PM on the CxA's standard issues tracking form.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work, loosening acceptance criteria, or combining CxA functional testing with the contractor QA checkout procedures to satisfy scheduling or cost.

4. A complete round of tests will be performed, with results and deficiencies reported to the Subs and the PM. The responsible Subs will then have an opportunity to correct the deficiencies and schedule re-testing. Re-testing of up to 10% of the total number of executed tests will be provided by the CxA at no additional charge. Costs of additional re-testing will be as described in the next section.

a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:

- 1) The CxA documents the deficiency and the Sub's response with intentions and they go on to another test or sequence. The Sub corrects the deficiency and notifies the CxA that the system is ready to be retested.
- 2) The CxA reschedules the test and the test is repeated.

b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

- 1) The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the PM and to the Sub representative assumed to be responsible.
- 2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.
- 3) The CxA documents the resolution process.
- 4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.

5. Cost of Retesting.

- a. The cost to retest a prefunctional or functional test beyond 10% of the total number of tests will be back-charged to the responsible Sub.
 - b. For a deficiency identified, not related to any prefunctional checklist or start-up fault, the following shall apply: The CxA and PM will direct the retesting of the equipment once at no “charge” to the GC for their time. However, the CxA’s time for a second test will be charged to the GC, who may choose to recover costs from the responsible Sub.
 - c. The time for the CxA to execute any re-testing required because a specific *prefunctional* checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be back-charged to the GC, who may choose to recover costs from the party responsible for executing the faulty prefunctional test.
 - d. Refer to the sampling section of Section 019113, Part 3.5 for requirements for testing and retesting identical equipment.
6. The Contractor shall respond in writing to the CxA and PM the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
 7. Any required re-testing shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.
- C. Approval: The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA and by the CM, if necessary. The CxA recommends acceptance of each test to the CM using a standard form.

3.7 OPERATION AND MAINTENANCE MANUALS AND FINAL REPORT

A. Standard O&M Manuals.

1. The specific content and format requirements for the standard O&M manuals are detailed in Division 01, with specific section requirements in Divisions 22, 23 & 26 for commissioned equipment.
2. CxA Review and Approval: Prior to substantial completion, the CxA shall review the O&M manuals, documentation and redline as-builds *for systems that were commissioned* to verify compliance with the *Specifications*. The CxA will communicate deficiencies in the manuals to the PM or A/E, as requested. Upon a successful review of the corrections, the CxA recommends approval and acceptance of these sections of the O&M manuals to the PM or A/E. The CxA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E’s review of the O&M manuals according to the A/E’s contract.

B. Final Commissioning Report

1. The final commissioning report shall include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas: 1) Equipment meeting the equipment specifications, 2) Equipment installation, 3) Functional performance and efficiency, 4) Equipment documentation and design intent, and 5) Operator training. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.
2. Other documentation will be retained by the CxA.

C. Systems Manual

1. The CxA will provide a Systems Manual in addition to the O&M Manuals submitted by the Contractor. The Systems Manual generally focuses on operating, rather than maintaining the equipment, particularly the interactions between equipment.

The Systems Manual shall include the following for each commissioned system:

- a. Final version of the Basis of Design
- b. System single line diagrams
- c. As-built sequences of operations, control drawings and original setpoints
- d. Operating instructions for integrated building systems
- e. Recommended schedule of maintenance requirements and frequency, if not already included in the project O&M manuals
- f. Recommended schedule for calibrating sensors and actuators

3.8 TRAINING OF OWNER PERSONNEL

- A. The GC shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.
- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment, as called for in the contract documents.
 1. The contractor will provide training for commissioned systems and equipment that covers the following topics:
 - a. General purpose of the system (design intent)
 - b. Use of the O&M manuals
 - c. Review of control drawings and schematics
 - d. Startup, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up and programming, troubleshooting, and alarms.
 - e. Interactions with other systems
 - f. Adjustments and optimizing methods for energy conservation
 - g. Relevant health and safety issues
 - h. Special maintenance and replacement sources
 - i. Tenant interaction issues
 - j. Discussion of environmentally responsive features of the system
 2. In addition to these general requirements, specific training requirements (duration, topics, etc...) of Owner personnel by Subs and vendors is specified in various equipment sections in Divisions 22, 23 & 26.
 3. Each Sub and vendor responsible for training will submit a written training plan to the CxA (on a form provided by the CxA) for review and approval prior to training. The plan will cover the following elements:
 - a. Equipment (included in training)
 - b. Intended audience
 - c. Location of training
 - d. Objectives
 - e. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
 - f. Subjects covered (description, duration of discussion, special methods, etc.)

- g. Duration of training on each subject
- h. Instructor for each subject

3.9 DEFERRED TESTING

- A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the PM. These tests will be conducted as soon as possible. Services of necessary parties will be negotiated.

3.10 WRITTEN WORK PRODUCTS

- A. The commissioning process generates a number of written work products described in various parts of the *Specifications*. The *Commissioning Plan* lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them.
- B. In summary, the written products are:

Item no.	Product	Developed by
01 9100-1	Equipment documentation submittals	Subs
01 9100-2	Sequence clarifications	Subs and A/E as needed
01 9100-3	Pre-functional checklists	CxA
01 9100-4	Start-up and initial checkout plan	Subs w/ assistance from CxA
01 9100-5	Pre-functional checklists filled out	Subs
01 9100-6	Start-up and initial checkout forms filled out	Subs
01 9100-7	Final TAB report	TAB
01 9100-8	Issues log (deficiencies)	CxA
01 9100-9	Functional test forms	CxA
01 9100-10	Filled out functional tests	CxA
01 9100-11	Training plans and records	Subs
01 9100-12	O&M manuals	Subs
01 9100-13	Systems Manual	CxA
01 9100-14	Final Commissioning Report	CxA

END OF SECTION 019113

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cast-in-place concrete formwork and accessories, for the following:
 - 1. Footings and grade beams.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.
 - 4. Concrete Toppings.
- B. Related Sections:
 - 1. Section 03 30 00 "Cast-In-Place Concrete".

1.3 REFERENCES

- A. Abbreviations & Acronyms
 - 1. ACI – American Concrete Institute
- B. Reference Standards
 - 1. ACI 301-10: Specification for Structural Concrete Buildings.
 - 2. ACI 117-10: Specification for Tolerances for Concrete Construction and Materials
 - 3. ACI 347-04: Guide to Formwork for Concrete

1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Form materials and form-release agents.

1.5 QUALITY ASSURANCE

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301-10, "Specifications for Structural Concrete for Buildings"
 - 2. ACI 117-10, "Specification for Tolerances for Concrete Construction and Materials"

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
 - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1 or better.
 - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
 - c. Structural 1, B-B or better; mill oiled and edge sealed.
 - d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- D. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- E. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
- F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- H. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class C, 1/2 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.3 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view or to receive a rubbed finish.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 - 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 - 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. All concrete work is subject to special inspection and testing. This section specifies the minimum testing and inspection required. Additional testing and inspection may be required by the Testing Agency, the Owner, or the Engineer/Architect if project conditions warrant.
- C. Special Inspector Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, and qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

- D. Tests and inspections shall be in conformance with Division 1, Section "Quality Requirements".
- E. Independent Testing Agency shall check batch tickets for compliance with required mix design(s).
- F. Continuous Field Inspection: The Independent Testing Agency shall be present at all times during the placing of structural reinforced concrete. Work shall not proceed until all inspections are completed. Prior to placing concrete, the Inspector shall inspect:
 - 1. Accuracy, configuration, and cleanliness of all formwork
 - 2. Quantity, cleanliness, and placement of all reinforcing steel.
 - 3. Testing Agency need not be present during entire reinforcing steel placing operations, provided he has inspected for conformance with the approved placement drawings prior to closing of forms or the delivery of concrete to the job site.
- G. No concrete shall be placed until placement of reinforcement steel has been inspected and approved. Provide 48 hours notice to the Inspector prior to placing concrete.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes concrete reinforcement for the following:

- 1. Footings and grade beams.
- 2. Foundation walls.
- 3. Slabs-on-grade.
- 4. Concrete Toppings.
- 5. Concrete Masonry Units

- B. Related Sections:

- 1. Section 03 30 00 "Cast-In-Place Concrete"

1.3 REFERENCES

- A. Abbreviations & Acronyms

- 1. ACI – American Concrete Institute
- 2. CRSI – Concrete Reinforcing Steel Institute

- B. Reference Standards

- 1. ACI 301-10: Specification for Structural Concrete Buildings.
- 2. ACI 117-10: Specification for Tolerances for Concrete Construction and Materials.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 Section "Administrative Requirements."

- B. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

- 1. Provide details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include special reinforcement required for openings through concrete structures.
- 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. Architect/Engineer will not review information outside of revision clouds on resubmitted drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For welder
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Steel reinforcement and accessories.

1.6 QUALITY ASSURANCE

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301-10, "Specifications for Structural Concrete for Buildings"
 - 2. ACI 117-10, "Specification for Tolerances for Concrete Construction and Materials"
- B. CRSI Publications: Comply with the following, unless more stringent provisions are indicated:
 - 1. Manual of Standard Practice
 - 2. Documents 63 and 65.
- C. Qualifications
 - 1. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Plain-Steel Wire: ASTM A 82/A 82M,
- C. Deformed-Steel Wire: ASTM A 496/A 496M.

2.2 REINFORCEMENT ACCESSORIES

- A. Tie Wire: Minimum 16 gage, ASTM A 82, or acceptable patented system.
- B. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- C. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

- D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
 3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.3 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Defective Work: The following reinforcing steel work will be considered defective, and shall be removed and replaced by the Contractor at no additional cost to the Owner:
1. Bars with kinks or bends not shown on the drawings.
 2. Bars damaged due to bending or straightening.
 3. Bars heated for bending.
 4. Reinforcement not placed in accordance with the drawings.

3.2 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. All concrete work is subject to special inspection and testing. This section specifies the minimum testing and inspection required. Additional testing and inspection may be required by the Testing Agency, the Owner, or the Engineer/Architect if project conditions warrant.

- C. Special Inspector Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, and qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- D. Tests and inspections shall be in conformance with Division 1, Section "Quality Requirements".
- E. Independent Testing Agency shall check batch tickets for compliance with required mix design(s).
- F. Inspections:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.
- G. Reinforcing Steel Testing: Independent Testing Agency will perform the following:
 - 1. All steel bars that can be positively identified as to heat number and mill analysis shall have one tensile test bending test for each 10 tons, or fraction thereof, for all #5 bars and larger.
 - 2. All steel bars that cannot be identified shall have one tensile and one bend test made for each 2 1/2 tons, or fraction thereof, of each size and kind of reinforcing steel.
 - 3. Testing procedure shall conform to ASTM A 615.
- H. Reinforcement Welding: All shop and field welds of reinforcing steel will be inspected. The Special Welding Inspector will check the materials and equipment, the qualifications and ability of the welder, and details of construction and procedure, as well as the welds themselves. The Inspector may use gamma ray, magneflux, trepanning, ultrasonics, or any other aid to visual inspection which the Inspector may deem necessary to determine the adequacy of the welding.
- I. No concrete shall be placed until placement of reinforcement steel has been inspected and approved. Provide 48 hours notice to the Inspector prior to placing concrete.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cast-in-place concrete, including, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings and grade beams.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.
 - 4. Concrete Toppings.
- B. Related Sections:
 - 1. Section 03 10 00 "Concrete Forming and Accessories"
 - 2. Section 03 20 00 "Concrete Reinforcing"
 - 3. Section 03 35 43 "Bonded Abrasive Polished Concrete Floors"
 - 4. Section 03 40 00 "Precast Concrete"
 - 5. Section 31 20 00 "Earth Moving" for drainage fill under slabs-on-grade.
 - 6. Section 32 13 13 "Concrete Paving" for concrete pavement and walks.
 - 7. Section 32 13 16 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.3 REFERENCES

- A. Abbreviations & Acronyms
 - 1. ACI – American Concrete Institute
 - 2. NRMCA – National Ready Mixed Concrete Association
- B. Definitions
 - 1. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
 - 2. W/C Ratio: The ratio by weight of water to cementitious materials.
- C. Reference Standards
 - 1. ACI 301-10: Specification for Structural Concrete Buildings.
 - 2. ACI 117-10: Specification for Tolerances for Concrete Construction and Materials

1.4 ADMINISTRATIVE REQUIREMENTS:

- A. Preinstallation Conference: Conduct conference at project site
 - 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 mixtures
 - c. Ready-mix concrete manufacturer
 - d. Concrete subcontractor
 - e. Special concrete finish subcontractor
 - 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, forms and form removal limitations, shoring and re-shoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.5 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 Section "Administrative Requirements."
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Submit proposed mix designs at least 15 days in advance of placing operations for each concrete mixture. The submitted mix design shall include the following:
 - a. Supporting strength test data not more than 12 months old. At the Engineer's request, reports from the independent testing agencies may be required to document the test data. Reports from the independent testing agencies will be required if fly ash is used in the design mix.
 - b. Statistical analysis in compliance with ACI 301.
 - c. Gradation of fine and coarse aggregates not more than 90 days old (ASTM C 33). No substitution of aggregate type or size from those submitted will be permitted.
 - d. Proportions of all ingredients, including all admixtures added either at time of batching or at job site. Aggregate weights shall be based upon saturated surface dry conditions.
 - e. Water/cement ratio.
 - f. Slump (ASTM C 143): When high range water-reducing admixtures are used, slump before and after addition of admixture are required.
 - g. Air content of freshly mixed concrete (ASTM C 231).
 - h. Material Certificates for the following:
 - 1) Cementitious Materials
 - 2) Admixtures
 - i. Certification that all ingredients in each mix design are compatible
 - j. Locations or intended use of each mix design.
 - k. Source of all materials.
 - l. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Embedded Item Placement Drawings: Drawings indicating the location and type of plates, anchorages, or other items to be embedded in the finished concrete surfaces. Include wall elevations, slab plans, and details required to locate and install embeds.
- D. Samples: For waterstops and vapor retarder.

- E. Saw Cut Joints: Indicate proposed locations for all saw cut joints not shown on the drawings.
 - 1. Location of saw cut joints is subject to approval of the Architect.
- F. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - 1. Location of construction joints is subject to approval of the Architect.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer, and testing agency.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Form materials and form-release agents.
 - 2. Steel reinforcement and accessories.
 - 3. Waterstops.
 - 4. Curing compounds.
 - 5. Floor and slab treatments.
 - 6. Bonding agents.
 - 7. Adhesives.
 - 8. Semirigid joint filler.
 - 9. Joint-filler strips.
 - 10. Repair materials.
- D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- E. Written curing procedure, including curing procedures for hot- and cold-weather placement.
- F. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- G. Field quality-control reports.
- H. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301-10, "Specifications for Structural Concrete for Buildings"
 - 2. ACI 117-10, "Specification for Tolerances for Concrete Construction and Materials"
- B. CRSI Publications: Comply with the following, unless more stringent provisions are indicated:
 - 1. Manual of Standard Practice
 - 2. Documents 63 and 65.
- C. Qualifications

1. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
 2. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
 3. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- E. Mockups: Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.
1. Build panel approximately 200 sq. ft. for slab-on-grade and 100 sq. ft. for formed surface in the location indicated or, if not indicated, as directed by Architect.
 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. Coordinate chemical and adhesion compatibility of curing compounds used for curing concrete with coatings, stains, paints, liquid flashings, sealers, waterproofing membranes, joint sealants and other materials that penetrate, adhere to or otherwise come into contact with concrete surfaces that are specified in other sections.
- G. Batch Tickets: Provide batch tickets for review by inspector for each truckload of concrete used in the work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of cement and water introduced.
- H. Concrete Finishing and Curing:
1. Obtain each type, composition, and variety of liquid membrane-forming curing compound used for the Project from the same manufacturer.
 2. Products from more than one approved manufacturer may be used for different applications, however all products for like applications shall be by the same manufacturer.
 3. Liquid membrane curing compound manufacturer qualifications: Obtain materials only from a manufacturer that will send an experienced technical field representative to the Project site before the start of work to verify existing conditions, and during the execution of work to perform manufacturer's field services.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Store materials in accordance with ACI 301. Admixtures which have been in storage at the project site for longer than six months or which have been subjected to freezing shall not be used, unless retested and proven to meet the specified requirements.

- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.9 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 and as follows:
 - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 - 2. Products: Subject to compliance with requirements, provide one of the products specified.
 - 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type II Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class C.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 - c. Silica Fume: ASTM C 1240, amorphous silica.
- B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate, graded. Provide aggregates from a single source.

1. Unless maximum aggregate size is listed specifically under "Project Mix Requirements," the maximum aggregate size shall not exceed:
 - a. Three-fourths of the minimum clear spacing between reinforcing bars.
 - b. One-fifth of the narrowest dimension between the sides of the forms.
 - c. One-third of the thickness of the slabs or toppings.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

2.3 ADMIXTURES

- A. General
1. Admixtures certified by manufacturer to contain not more than 0.05 percent water-soluble chloride ions by mass of cementitious material. Do not use admixtures containing calcium chloride or thiocyanate.
 2. Where more than one admixture is used in the mix, furnish manufacturer's certification to the Architect that the admixtures to be used are compatible in combination with the cement and aggregates.
 3. Accelerating admixtures shall not be used.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- A. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.
1. Products:
 - a. Axim Italcementi Group, Inc.; CATExOL CN-CI.
 - b. BASF Construction Chemicals – Building Systems; Rheocrete CNI.
 - c. Euclid Chemical Company (The); Eucon, CIA.
 - d. Grace Construction Products, W.R. Grace & Co.; DCI.
 - e. Sika Corporation; Sika CNI.
- A. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
1. Products:
 - a. BASF Construction Chemicals – Building Systems; Rheocrete 222+.
 - b. Cortec Corporation; MCI [2000] [2005NS].
 - c. Grace Construction Products, W.R. Grace & Co.; DCI-S.
 - d. Sika Corporation; FerroGard-901.

- B. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ChemMasters.
 - b. Davis Colors.
 - c. Dayton Superior Corporation.
 - d. Hoover Color Corporation.
 - e. Lambert Corporation.
 - f. QC Construction Products.
 - g. Rockwood Pigments NA, Inc.
 - h. Scofield, L. M. Company.
 - i. Solomon Colors, Inc.
 - 2. Color: As selected by Architect from manufacturer's full range.

2.4 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513 for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Profile: As indicated.
 - 2. Dimensions: 6 inches by 3/8 inch thick; nontapered.
- B. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

2.5 VAPOR RETARDERS

- A. Plastic Vapor Retarder: ASTM E 1745, Class A. 15-mil minimum thickness, unless noted otherwise on the drawings. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 - 1. Products:
 - a. Fortifiber Corporation; Moistop Ultra A 15.
 - b. Raven Industries Inc.; Vapor Block 15.
 - c. Reef Industries, Inc.; Griffolyn Type-105.

2.6 FLOOR AND SLAB TREATMENTS

- A. Emery Dry-Shake Floor Hardener: Unpigmented, factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.
 - 1. Color: As selected by Architect from manufacturer's full range.
- B. Metallic Dry-Shake Floor Hardener: Unpigmented, factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

1. Color: selected by Architect from manufacturer's full range.
- C. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Construction Chemicals - Building Systems; Maximent.
 - b. ChemMasters; ConColor.
 - c. Conspec by Dayton Superior; Conshake 500.
 - d. Dayton Superior Corporation; Quartz Tuff.
 - e. Edoco by Dayton Superior; Burke Non Metallic Floor Hardener 250.
 - f. Euclid Chemical Company (The), an RPM company; Surflex.
 - g. Kaufman Products, Inc.; Tycron.
 - h. Lambert Corporation; Colorhard.
 - i. L&M Construction Chemicals, Inc.; Quartzplate FF.
 - j. Metalcrete Industries; Floor Quartz.
 - k. Scofield, L. M. Company; Lithochrome Color Hardener.
 - l. Symons by Dayton Superior; Hard Top.
 2. Color: As selected by Architect from manufacturer's full range.

2.7 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ChemMasters; Chemisil Plus.
 - b. ChemTec Int'l; ChemTec One.
 - c. Conspec by Dayton Superior; Intraseal.
 - d. Curecrete Distribution Inc.; Ashford Formula.
 - e. Dayton Superior Corporation; Day-Chem Sure Hard (J-17).
 - f. Edoco by Dayton Superior; Titan Hard.
 - g. Euclid Chemical Company (The), an RPM company; Euco Diamond Hard.
 - h. Kaufman Products, Inc.; SureHard.
 - i. L&M Construction Chemicals, Inc.; Seal Hard.
 - j. Meadows, W. R., Inc.; LIQUI-HARD.
 - k. Metalcrete Industries; Floorsaver.
 - l. Nox-Crete Products Group; Duro-Nox.
 - m. Symons by Dayton Superior; Buff Hard.
 - n. US SPEC, Division of US Mix Products Company; US SPEC Industraseal.
 - o. Vexcon Chemicals, Inc.; Vexcon StarSeal PS Clear.

2.8 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 1. Products:

- a. Dayton Superior Corporation; Sure Film.
 - b. Euclid Chemical Company (The); Eucobar.
 - c. Sika Corporation, Inc.; SikaFilm.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.9 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber
- A. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.10 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.

4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 1. Fly Ash: 25 percent.
 2. Combined Fly Ash and Pozzolan: 25 percent.
 3. Ground Granulated Blast-Furnace Slag: 50 percent.
 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
 5. Silica Fume: 10 percent.
 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
 7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. Slump: As indicated on the drawings.
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
 1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Concrete mix design shall comply with the requirements of the structural drawings.

2.13 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
 2. Install connection plates, angles, or other embedded items flush with concrete surface and at accurate locations per the approved embedded item placement drawings required by Part 1, "Submittals," section.

3.2 VAPOR RETARDER INSTALLATION

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
 1. Lap joints 6 inches and seal with manufacturer's recommended tape.
- B. Bituminous Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions.

3.3 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls at maximum of 30-foot spacing. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

8. Provide roughened surfaces at joints where shown on the drawings. Roughen to a full amplitude of approximately 1/4-inch.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.4 WATERSTOP INSTALLATION

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section

cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.6 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces exposed to public view or to receive a rubbed finish.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces.

Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.7 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. 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 (6 mm) in one direction.
 - 1. Apply scratch finish to receive mortar setting beds for bonded cementitious floor finishes.
- C. 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 restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces to receive trowel finish.
- D. Trowel Finish: 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.
 - 1. Apply a trowel finish to surfaces indicated to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
- E. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
 - 1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in 1 or 2 applications. Tamp aggregate flush with surface, but do not force below surface.
 - 2. After broadcasting and tamping, apply float finish.
 - 3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

3.8 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.9 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 1. Defer joint filling until concrete has aged at least **[one]** **[six]** month(s). Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.11 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete. Limit cut depth to 3/4 inch (19 mm). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.12 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. All concrete work is subject to special inspection and testing. This section specifies the minimum testing and inspection required. Additional testing and inspection may be required by the Testing Agency, the Owner, or the Engineer/Architect if project conditions warrant.
- C. Special Inspector Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, and qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- D. Tests and inspections shall be in conformance with Division 1, Section "Quality Requirements".
- E. Independent Testing Agency shall check batch tickets for compliance with required mix design(s).
- F. Continuous Field Inspection: The Independent Testing Agency shall be present at all times during the placing of structural reinforced concrete. Work shall not proceed until all inspections are completed. Prior to placing concrete, the Inspector shall inspect:
1. Accuracy, configuration, and cleanliness of all formwork
 2. Quantity, cleanliness, and placement of all reinforcing steel.
 3. Testing Agency need not be present during entire reinforcing steel placing operations, provided he has inspected for conformance with the approved placement drawings prior to closing of forms or the delivery of concrete to the job site.

- G. Inspections:
1. Headed bolts and studs.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
- H. No concrete shall be placed until placement of reinforcement steel has been inspected and approved. Provide 48 hours notice to the Inspector prior to placing concrete.
- I. Concrete Sampling: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. At the Contractor's expense and direction, cast and field-cure standard cylinder specimens as may be required for construction. Number of specimens and testing age shall be determined by the Contractor based on construction sequence requirements.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test field-cured specimens at the Contractor's direction.
 7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
 10. Linear Shrinkage Tests: Test for linear shrinkage in accordance with ASTM C 157 (air storage method for 28 days. Take a minimum of 3 test samples from each mix, at the Project Representative's direction, of concrete for elevated slabs and beams. Take samples at truck and discharge end of pumped mix. Consistency of the concrete must not be altered after test samples have been taken.

11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
 13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 14. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.
- J. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.
1. Finish surfaces to the following tolerances, for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
 - b. Specified overall values of flatness, F(F) 30; with minimum local values of flatness, F(F) 24; for suspended slabs.
 - c. Specified overall values of flatness, F(F) 40; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for concrete receiving polished concrete finish.

3.13 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION

SECTION 075216 - STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMENOUS
MEMBRANE ROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hot Applied 2-Ply SBS Asphalt Roofing.
- B. Roof Insulation.
- C. Edge Treatment and Roof Penetration Flashings.

1.2 RELATED SECTIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.3 DESIGN / PERFORMANCE REQUIREMENTS

- A. Perform work in accordance with all federal, state and local codes.
- B. Exterior Fire Test Exposure: Roof system shall achieve a UL, FM or WH Class rating for roof slopes indicated on the Drawings as follows:
 - 1. Factory Mutual Class A Rating.
 - 2. Underwriters Laboratory Class A Rating.
 - 3. Warnock Hersey Class A Rating.
- C. Design Requirements:
 - 1. Uniform Wind Uplift Load Capacity
 - a. Installed roof system shall withstand negative (uplift) design wind loading pressures complying with the following criteria.
 - 1) Design Code: ASCE 7-10, Method 2 for Components and Cladding.
 - 2) ASCE 7-10 calculations shall be provided by Roofing System Manufacturer and be sealed by a P.E. employed by the Manufacturer.:
- D. Energy Star: Roof System shall comply with the initial and aged reflectivity required by the U.S. Federal Government's Energy Star program.
- E. LEED: Roof system shall meet the reflectivity and emissivity criteria to qualify for one point under the LEED credit category, Credit 7.2, Landscape & Exterior Design to Reduce Heat Island - Roof.
- F. Roof System membranes containing recycled or bio-based materials shall be third party certified through UL Environment.

1.4 SUBMITTALS

- A. 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. Installation instructions.

- B. Shop Drawings: Submit shop drawings including installation details of roofing, flashing, fastening, insulation and vapor barrier, including notation of roof slopes and fastening patterns of insulation and base modified bitumen membrane, prior to job start.
- C. Design Pressure Calculations: Submit design pressure calculations for the roof area in accordance with ASCE 7-10 and local Building Code requirements. Include a roof system attachment analysis report, certifying the system's compliance with applicable wind load requirements before Work begins. Report shall be signed and sealed by a Professional Engineer registered in the State of the Project who has provided roof system attachment analysis for not less than 5 consecutive years.
- D. LEED Submittals: Provide documentation of how the requirements of Credit will be met:
 - 1. List of proposed materials with recycled content. Indicate post-consumer recycled content and pre-consumer recycled content for each product having recycled content.
 - 2. Product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content.
 - 3. Product reflectivity and emissivity criteria to qualify for one point under the LEED credit category, Credit 7.2, Landscape & Exterior Design to Reduce Heat Island - Roof.
- E. Recycled or Bio-Based Materials: Provide third party certification through UL Environment of roof System membranes containing recycled or bio based materials
- F. Verification Samples: For each modified bituminous membrane ply product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.
- G. Manufacturer's Certificates: Provide to certify products meet or exceed specified requirements.
- H. Test Reports: Submit test reports, prepared by an independent testing agency, for all modified bituminous sheet roofing, indicating compliance with ASTM D5147. Testing must be performed at 77 deg. F. Tests at 0 deg. F will not be considered.
- I. Manufacturer's Fire Compliance Certificate: Certify that the roof system furnished is approved by Factory Mutual (FM), Underwriters Laboratories (UL), Warnock Hersey (WH) or approved third party testing facility in accordance with ASTM E108, Class A for external fire and meets local or nationally recognized building codes.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with NRCA Roofing and Waterproofing Manual.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified with documented ISO 9001 certification and minimum of twelve years of documented experience and currently hold the US Communities Co-Operative Purchasing Alliance Contract.
- C. Installer Qualifications: Company specializing in performing Work of this section with minimum five years documented experience and a certified Pre-Approved Garland Contractor.

- D. Installer's Field Supervision: Maintain a full-time Supervisor/Foreman on job site during all phases of roofing work while roofing work is in progress.
- E. Product Certification: Provide manufacturer's certification that materials are manufactured in the United States and conform to requirements specified herein, are chemically and physically compatible with each other, and are suitable for inclusion within the total roof system specified herein.

1.6 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.7 WARRANTY

- A. Upon completion of the work, provide the Manufacturer's written and signed NDL Warranty, warranting that, if a leak develops in the roof during the term of this warranty, due either to defective material or defective workmanship by the installing contractor, the manufacturer shall provide the Owner, at the Manufacturer's expense, with the labor and material necessary to return the defective area to a watertight condition.
 - 1. Warranty Period:
 - a. 30 years from date of acceptance.
- B. Installer is to guarantee all work against defects in materials and workmanship for a period indicated following final acceptance of the Work.
 - 1. Warranty Period:
 - a. 3 years from date of acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Manufacturer shall currently hold the US Communities Co-Operative Purchases Alliance Contract. All products shall be provided according to the same terms and conditions of US Communities Contract.
 - 1. Basis-of-Design: The Garland Company, Stressply E FR Mineral (Environmental).
 - 2. Or approved equal.

2.2 HOT APPLIED 2-PLY ASPHALT ROOFING - STRESSPLY

- A. Base (Ply) Sheet: One ply bonded to the prepared substrate with Interply Adhesive:
 - 1. StressBase 80:
- B. Modified Cap (Ply) Sheet: One ply bonded to the prepared substrate with Interply Adhesive.
 - 1. StressPly E FR Mineral (Environmental):
- C. Interply Adhesive: (1 and 2)
 - 1. Generic Type III Asphalt:
- D. Flashing Base Ply: One ply bonded to the prepared substrate with Interply Adhesive: except torch sheet.
 - 1. StressBase 80:

- E. Flashing Cap (Ply) Sheet: One ply bonded to the prepared substrate with Interply Adhesive: except torch sheet.
 - 1. StressPly E FR Mineral (Environmental):
- F. Flashing Ply Adhesive:
 - 1. Generic Type III Asphalt::
- G. Surfacing:
 - 1. Surface Coatings
 - a. Pyramic:

2.3 ROOF INSULATION

- A. Roof Insulation: Two layers, 2.5" Polyisocyanurate insulation, first layer to mechanically fastened according to ASCE 7-10 requirements. Second layer of insulation to be solidly mopped in type III asphalt.
- B. Roof Insulation: Protection recovery board shall be high density coated wood fiberboard solidly adhered in Type III hot asphalt.
- C. Roof Insulation: Crickets shall be Polyisocyanurate insulation, a minimum of 1/2";12" slope as indicated on drawings and will eliminate all ponding.

2.4 EDGE TREATMENT AND ROOF PENETRATION FLASHINGS

- A. Flashing Boot - Rubbertite Flashing Boot: Neoprene pipe boot for sealing single or multiple pipe penetrations adhered in approved adhesives as recommended and furnished by the membrane manufacturer.
- B. Vents and Breathers: Heavy gauge aluminum and fully insulated vent that allows moisture and air to escape but not enter the roof system as recommended and furnished by the membrane manufacturer.
- C. Pitch pans, Rain Collar 24 gauge stainless or 20oz (567gram) copper. All joints should be welded/soldered watertight. See details for design.
- D. Drain Flashings should be 4lb (1.8kg) sheet lead formed and rolled.
- E. Plumbing stacks should be 4lb (1.8kg) sheet lead formed and rolled.
- F. Liquid Flashing - Tuff-Flash: An asphaltic-polyurethane, low odor, liquid flashing material designed for specialized details unable to be waterproofed with typical modified membrane flashings.
 - 1. Tensile Strength, ASTM D 412: 400 psi
 - 2. Elongation, ASTM D 412: 300%
 - 3. Density @77 deg. F 8.5 lb/gal typical
- G. Fabricated Flashings: Fabricated flashings and trim are specified in Section 07620.
 - 1. Fabricated flashings and trim shall conform to the detail requirements of SMACNA "Architectural Sheet Metal Manual" and/or the CDA Copper Development Association "Copper in Architecture - Handbook" as applicable.
- H. Manufactured Roof Specialties: Manufactured copings, fascia, gravel stops, control joints,

expansion joints, joint covers and related flashings and trim are specified in Section 07710.

1. Manufactured roof specialties shall conform to the detail requirements of SMACNA "Architectural Sheet Metal Manual" and/or the NRCA "Roofing and Waterproofing Manual" as applicable.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Inspect and approve the deck condition, slopes and fastener backing if applicable, parapet walls, expansion joints, roof drains, stack vents, vent outlets, nailers and surfaces and elements.
- C. Verify that work penetrating the roof deck, or which may otherwise affect the roofing, has been properly completed.
- D. If substrate preparation and other conditions are the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. General: Clean surfaces thoroughly prior to installation.
 1. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
 2. Fill substrate surface voids that are greater than 1/4 inch wide with an acceptable fill material.
 3. Roof surface to receive roofing system shall be smooth, clean, free from loose gravel, dirt and debris, dry and structurally sound.
 4. Wherever necessary, all surfaces to receive roofing materials shall be power broom and vacuumed to remove debris and loose matter prior to starting work.
 5. Do not apply roofing during inclement weather. Do not apply roofing membrane to damp, frozen, dirty, or dusty surfaces.
 6. Fasteners and plates for fastening components mechanically to the substrate shall provide a minimum pull-out capacity of 300 lbs. (136 k) per fastener. Base or ply sheets attached with cap nails require a minimum pullout capacity of 40 lb. per nail.
 7. Prime decks where required, in accordance with requirements and recommendations of the primer and deck manufacturer.
- B. Metal Deck: Metal deck shall be installed as specified in Section
 1. Fastening of the deck should comply with the anticipated live and dead loads pertaining to the building as well as applicable Code.
 2. Steel decks shall be minimum 22-gauge factory galvanized or zinc alloy coated for protection against corrosion.
 3. Suitable insulation shall be mechanically attached as recommended by the insulation manufacturer.
 4. Decks shall comply with the gauge and span requirements in the current Factory Mutual FM Approval Guide and be installed in accordance with Loss Prevention Data Sheet 1-28 or specific FM approval.
 5. When re-roofing over steel decks, surface corrosion shall be removed, and repairs to

severely corroded areas made. Loose or inadequately secured decking shall be fastened, and irreparable or otherwise defective decking shall be replaced.

3.3 INSTALLATION - GENERAL

- A. Install modified bitumen membranes and flashings in accordance with manufacturer's instructions and with the recommendations provided by the National Roofing Contractors Association's Roofing & Waterproofing Manual, the Asphalt Roofing Manufacturers Association, and applicable codes.
- B. General: Avoid installation of modified bitumen membranes at temperatures lower than 40-45 degrees F. When work at such temperatures unavoidable use the following precautions:
 - 1. Take extra care during cold weather installation and when ambient temperatures are affected by wind or humidity, to ensure adequate bonding is achieved between the surfaces to be joined. Use extra care at material seam welds and where adhesion of the applied product to the appropriately prepared substrate as the substrate can be affected by such temperature constraints as well.
 - 2. Unrolling of cold materials, under low ambient conditions must be avoided to prevent the likelihood of unnecessary stress cracking. Rolls must be at least 40 degrees F at the time of application. If the membrane roll becomes stiff or difficult to install, it must be replaced with roll from a heated storage area.
- C. Commence installation of the roofing system at the lowest point of the roof (or roof area), working up the slope toward the highest point. Lap sheets shingle fashion so as to constantly shed water

3.4 INSTALLATION HOT APPLIED ROOF SYSTEM

- A. Base/Felt Ply(s): Install base sheet or felt plies in twenty five (25) lbs (11.3kg) per square of bitumen shingled uniformly to achieve one or more plies over the entire prepared substrate. Shingle in direction of slope of roof to shed water on each area of roof. Do not step on base rolls until asphalt has cooled, fish mouths should be cut and patched.
 - 1. Lap ply sheet ends 8 inches (203 mm). Stagger end laps 2 inches (304mm) minimum.
 - 2. Install base flashing ply to all perimeter and projection details after membrane application.
 - 3. Extend plies 2 inches beyond top edges of cants at wall and projection bases.
 - 4. Install base flashing ply to all perimeter and projection details.
 - 5. Allow the one ply of base sheet to cure at least 30 minutes before installing the modified membrane. However, the modified membrane must be installed the same day as the base plies.
- B. Modified Cap Ply(s): Solidly bond the modified membrane to the base layers with specified material at the rate of 25 to thirty 30 lbs. (11-13kg) per 100 square feet.
 - 1. Roll must push a puddle of hot material in front of it with material slightly visible at all side laps. Use care to eliminate air entrapment under the membrane. Exercise care during application to eliminate air entrapment under the membrane.
 - 2. Apply pressure to all seams to ensure that the laps are solidly bonded to substrate.
 - 3. Install subsequent rolls of modified membrane as above with a minimum of 4 inch (101 mm) side laps and 8 inch (203 mm) end laps. Stagger end laps. Apply membrane in the same direction as the previous layers but stagger the laps so they do not coincide with the laps of the base layers.

4. Apply hot material no more than 5 feet (1.5 m) ahead of each roll being embedded.
 5. Extend membrane 2 inches (50 mm) beyond top edge of all cants in full moppings of the specified hot material.
- C. Fibrous Cant Strips: Provide non-combustible perlite or glass fiber cant strips at all wall/curb detail treatments where angle changes are greater than 45 degrees. Cant may be set in approved cold adhesives, hot asphalt or mechanically attached with approved plates and fasteners.
- D. Wood Blocking, Nailers and Cant Strips: Provide wood blocking, nailers and cant strips as specified in Section 06114.
1. Provide nailers at all roof perimeters and penetrations for fastening membrane flashings and sheet metal components.
 2. Wood nailers should match the height of any insulation, providing a smooth and even transition between flashing and insulation areas.
 3. Nailer lengths should be spaced with a minimum 1/8 inch gap for expansion and contraction between each length or change of direction.
 4. Nailers and flashings should be fastened in accordance with Factory Mutual "Loss Prevention Data Sheet 1- 49, Perimeter Flashing" and be designed to be capable of resisting a minimum force of 200 lbs/lineal foot in any direction.
- E. Metal Work: Provide metal flashings, counter flashings, parapet coping caps and thru-wall flashings as specified in Section 07620 or Section 07710. Install in accordance with the SMACNA "Architectural Sheet Metal Manual" or the NRCA Roofing Waterproofing manual.
- F. Termination Bar: Provide a metal termination bar or approved top edge securement at the terminus of all flashing sheets at walls and curbs. Fasten the bar a minimum of 8 inches (203 mm) o/c to achieve constant compression. Provide suitable, sealant at the top edge if required.
- G. Flashing Base Ply: Install flashing sheets by the same application method used for the base ply.
1. Seal curb, wall and parapet flashings with an application of mastic and mesh on a daily basis. Do not permit conditions to exist that will allow moisture to enter behind, around or under the roof or flashing membrane.
 2. Prepare all walls, penetrations, expansion joints and surfaces to be flashed with required primer at the rate of 100 square feet per gallon. Allow primer to dry tack free.
 3. Adhere to the underlying base flashing ply with specified hot material unless otherwise noted in these specifications. Nail off at a minimum of 8 inches (203 mm) o.c. from the finished roof at all vertical surfaces.
 4. Solidly adhere the entire sheet of flashing membrane to the substrate.
 5. Seal all vertical laps of flashing membrane with a three-course application of trowel-grade mastic and mesh.
 6. Coordinate counter flashing, cap flashings, expansion joints, and similar work with modified bitumen roofing work as specified.
 7. Coordinate roof accessories, miscellaneous sheet metal accessory items, including piping vents and other devices with the roofing system work.
- H. Flashing Cap Ply: Install flashing cap sheets by the same application method used for the base ply.

1. Seal curb, wall and parapet flashings with an application of mastic and mesh on a daily basis. Do not permit conditions to exist that will allow moisture to enter behind, around or under the roof or flashing membrane.
 2. Prepare all walls, penetrations, expansion joints and where shown on the Drawings to be flashed with required primer at the rate of 100 square feet per gallon. Allow primer to dry tack free.
 3. Adhere to the underlying base flashing ply with specified flashing ply adhesive unless otherwise specified. Nail off at a minimum of 8 inches (203 mm) o.c. from the finished roof at all vertical surfaces.
 4. Coordinate counter flashing, cap flashings, expansion joints and similar work with modified bitumen roofing work as specified.
 5. Coordinate roof accessories, miscellaneous sheet metal accessory items with the roofing system work.
 6. All stripping shall be installed prior to flashing cap sheet installation.
 7. Heat and scrape granules when welding or adhering at cut areas and seams to granular surfaces at all flashings.
 8. Secure the top edge of the flashing sheet using a termination bar only when the wall surface above is waterproofed, or nailed 4 inches on center and covered with an acceptable counter flashing.
- I. Surface Coatings: Apply roof coatings in strict conformance with the manufacturer's recommended procedures.
- J. Roof Walkways: Provide walkways in areas indicated on the Drawings.

3.5 INSTALLATION EDGE TREATMENT AND ROOF PENETRATION FLASHING

- A. Equipment Support:
1. Minimum curb height is 8 inches (203 mm) above finished roof height. Prime vertical at a rate of 100 square feet per gallon and allow to dry.
 2. Set cant in bitumen. Run all field plies over cant a minimum of 2 inches (50 mm).
 3. Install base flashing ply covering curb set in bitumen with 6 inches (152 mm) on to field of the roof.
 4. Install a second ply of modified flashing ply in bitumen over the base flashing ply, 9 inches (228 mm) on to the field of the roof. Attach top of membrane to top of curb and nail at 8 inches (203 mm) o.c. Apply a three-course application of mastic and mesh at all vertical seams and allow to cure and aluminize.
 5. Install pre-manufactured cover. Fasten sides at 24 inches (609 mm) o.c. with fasteners and neoprene washers. Furnish all joint cover laps with butyl tape between metal covers.
 6. Set equipment on neoprene pad and fasten as required by equipment manufacturer.
- B. Curb Detail/Air Handling Station:
1. Minimum curb height is 8 inches (203 mm) above finished roof height. Prime vertical at a rate of 100 square feet per gallon and allow to dry.
 2. Set cant in bitumen. Run all field plies over cant a minimum of 2 inches (50 mm).
 3. Install base flashing ply covering curb set in bitumen with 6 inches (152 mm) on to field of the roof.
 4. Install a second ply of modified flashing ply in bitumen over the base flashing ply, 9 inches (228 mm) on to the field of the roof. Apply a three-course application of mastic and mesh at all vertical seams and allow to cure and aluminize.

5. Install pre-manufactured counterflashing with fasteners and neoprene washers or per manufacturer's recommendations.
 6. Set equipment on neoprene pad and fasten as required by equipment manufacturer.
- C. Passive Vent/Air Intake:
1. Minimum curb height is 8 inches (203 mm) above finished roof height. Prime vertical at a rate of 100 square feet per gallon and allow to dry.
 2. Set cant in bitumen. Run all plies over cant a minimum of 2 inches (50 mm).
 3. Install base flashing ply covering curb with 6 inches (152mm) on to the field of the roof.
 4. Install a second ply of modified flashing ply installed over the base flashing ply, 9 inches (228 mm) on to field of the roof. Attach top of membrane to top of wood curb and nail at 8 inches (203 mm) o.c. Apply a three-course application of mastic and mesh at all vertical seams and allow to cure and aluminize.
 5. Install passive vent/air intake over the wood nailers and flashing to act as counterflashing. Fasten per manufacturer's recommendations.
- D. Roof Drain:
1. Plug drain to prevent debris from entering plumbing.
 2. Taper insulation to drain minimum of 24 inches (609 mm) from center of drain.
 3. Run roof system plies over drain. Cut out plies inside drain bowl.
 4. Set lead/copper flashing (30 inch square minimum) in 1/4 inch bed of mastic. Run lead/copper into drain a minimum of 2 inches (50 mm). Prime lead/copper at a rate of 100 square feet per gallon and allow to dry.
 5. Install base flashing ply (40 inch square minimum) in bitumen.
 6. Install modified membrane (48 inch square minimum) in bitumen.
 7. Install clamping ring and assure that all plies are under the clamping ring.
 8. Remove drain plug and install strainer.
- E. Plumbing Stack:
1. Minimum stack height is 12 inches (609 mm).
 2. Run roof system over the entire surface of the roof. Seal the base of the stack with elastomeric sealant.
 3. Prime flange of new sleeve. Install properly sized sleeves set in 1/4 inch (6 mm) bed of roof cement.
 4. Install base flashing ply in bitumen.
 5. Install membrane in bitumen.
 6. Caulk the intersection of the membrane with elastomeric sealant.
 7. Turn sleeve a minimum of 1 inch (25 mm) down inside of stack.

3.6 PROTECTION

- A. Provide traffic ways, erect barriers, fences, guards, rails, enclosures, chutes and the like to protect personnel, roofs and structures, vehicles and utilities.
- B. Protect exposed surfaces of finished walls with tarps to prevent damage.
- C. Plywood for traffic ways required for material movement over existing roofs shall be not less than 5/8 inch (16 mm) thick.
- D. In addition to the plywood listed above, an underlayment of minimum 1/2 inch (13 mm)

recover board is required on new roofing.

- E. Special permission shall be obtained from the Manufacturer before any traffic shall be permitted over new roofing.

3.7 FIELD QUALITY CONTROL

- A. Inspection: Provide manufacturer's field observations at start-up and at intervals of approximately 30 percent, 60 percent and 90 percent completion. Provide a final inspection upon completion of the Work.
 - 1. Warranty shall be issued upon manufacturer's acceptance of the installation.
 - 2. Field observations shall be performed by a Technical Representative employed full-time by the manufacturer and whose primary job description is to assist, inspect and approve membrane installations for the manufacturer.
 - 3. Provide observation reports from the Technical Representative indicating procedures followed, weather conditions and any discrepancies found during inspection.
 - 4. Provide a final report from the Technical Representative, certifying that the roofing system has been satisfactorily installed according to the project specifications, approved details and good general roofing practice.

3.8 SCHEDULES

- A. Base (Ply) Sheet:
 - 1. StressBase 80: 80 mil SBS (Styrene-Butadiene-Styrene) rubber modified roofing base sheet reinforced with a fiberglass scrim, performance requirements according to ASTM D 5147.
 - a. Tensile Strength, ASTM D 5147
 - 1) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 100 lbf/in XD 100 lbf/in
 - 2) 50mm/min. @ 23 +/- 2 deg. C MD 17.5 kN/m XD 17.5 kN/m
 - b. Tear Strength, ASTM D 5147
 - 1) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 110 lbf XD 110 lbf
 - 2) 50mm/min. @ 23 +/- 2 deg. C MD 489 N XD 489 N
 - c. Elongation at Maximum Tensile, ASTM D 5147
 - 1) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 2.5 % XD 2.5 %
 - 2) 50mm/min @ 23 +/- 2 deg. C MD 2.5 % XD 2.5 %
 - d. Low Temperature Flexibility, ASTM D 5147, Passes -20 deg. F (-28.8 deg. C)
- B. Modified Cap (Ply) Sheet:
 - 1. StressPly E FR Mineral (Environmental): 160 mil SBS and SIS (Styrene-Butadiene-Styrene and Styrene-Isoprene-Styrene) mineral surfaced rubber modified roofing membrane with fire retardant characteristics and reinforced with a dual fiberglass scrim and polyester scrim. ASTM D 6162, Type III Grade G
 - a. Tensile Strength, ASTM D 5147
 - 1) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 500 lbf/in XD 550 lbf/in
 - 2) 50 mm/min. @ 23 +/- 2 deg. C MD 87.5 kN/m XD 96.25 kN/m
 - b. Tear Strength, ASTM D 5147
 - 1) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 900 lbf XD 950 lbf
 - 2) 50 mm/min. @ 23 +/- 2 deg. C MD 4003 N XD 4226 N
 - c. Elongation at Maximum Tensile, ASTM D 5147
 - 1) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 6.0% XD 6.0%
 - 2) 50 mm/min. @ 23 +/- 2 deg. C MD 6.0% XD 6.0%

- d. Low Temperature Flexibility, ASTM D 5147, Passes -30 deg. F (-34 deg. C)
- C. Interply Adhesive:
 - 1. Generic Type III Asphalt: Hot Bitumen, ASTM D 312, Type III steep asphalt having the following characteristics:
 - a. Softening Point 185 deg. F - 205 deg. F
 - b. Flash Point 500 deg. F
 - c. Penetration @ 77 deg. F 15-35 units
 - d. Ductility @ 77 deg. F 2.5 cm
- D. Flashing Base Ply:
 - 1. StressBase 80: 80 mil SBS (Styrene-Butadiene-Styrene) rubber modified roofing base sheet reinforced with a fiberglass scrim, performance requirements according to ASTM D 5147.
 - a. Tensile Strength, ASTM D 5147
 - 1) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 100 lbf/in XD 100 lbf/in
 - 2) 50mm/min. @ 23 +/- 2 deg. C MD 17.5 kN/m XD 17.5 kN/m
 - b. Tear Strength, ASTM D 5147
 - 1) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 110 lbf XD 110 lbf
 - 2) 50mm/min. @ 23 +/- 2 deg. C MD 489 N XD 489 N
 - c. Elongation at Maximum Tensile, ASTM D 5147
 - 1) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 2.5 % XD 2.5 %
 - 2) 50mm/min @ 23 +/- 2 deg. C MD 2.5 % XD 2.5 %
 - d. Low Temperature Flexibility, ASTM D 5147
 - 1) Passes -20 deg. F (-28.8 deg. C)
- E. Flashing Ply Adhesive:
 - 1. Generic Type III Asphalt: Hot Bitumen, ASTM D 312, Type III steep asphalt having the following characteristics:
 - a. Softening Point 185 deg. F - 205 deg. F
 - b. Flash Point 500 deg. F
 - c. Penetration @ 77 deg. F 15-35 units
 - d. Ductility @ 77 deg. F 2.5 cm
- F. Surfacing:
 - 1. Flashing Cap (Ply) Sheet:
 - a. StressPly E FR Mineral (Environmental): 160 mil SBS and SIS (Styrene-Butadiene-Styrene and Styrene-Isoprene-Styrene) mineral surfaced rubber modified roofing membrane with fire retardant characteristics and reinforced with a dual fiberglass scrim and polyester scrim. ASTM D 6162, Type III Grade G
 - 1) Tensile Strength, ASTM D 5147
 - a) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 500 lbf/in XD 550 lbf/in
 - b) 50 mm/min. @ 23 +/- 2 deg. C MD 87.5 kN/m XD 96.25 kN/m
 - 2) Tear Strength, ASTM D 5147
 - a) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 900 lbf XD 950 lbf
 - b) 50 mm/min. @ 23 +/- 2 deg. C MD 4003 N XD 4226 N
 - 3) Elongation at Maximum Tensile, ASTM D 5147
 - a) 2 in/min. @ 73.4 +/- 3.6 deg. F MD 6.0% XD 6.0%
 - b) 50 mm/min. @ 23 +/- 2 deg. C MD 6.0% XD 6.0%

- 4) Low Temperature Flexibility, ASTM D 5147, Passes -30 deg. F (-34 deg. C)
2. Surface Coatings:
 - a. Surfacing:
 - 1) Pyramic: White elastomeric roof coating, Energy Star approved acrylic roof coating:
 - a) Weight/Gallon 12 lbs./gal. (1.44 g/cm³)
 - b) Non-Volatile % (ASTM D 1644) 66 min
 - c) Reflectance 81%

END OF SECTION

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

- 1. Commercial door hardware for the following:

- a. **Swinging doors.**
- b. **Other doors to the extent indicated.**

- 2. **Cylinders for doors specified in other Sections.**
- 3. **Electrified door hardware.**

- B. Related Sections include the following:

- 1. **Division 08 Section "Hollow Metal Doors and Frames"**
- 2. **Division 08 Section "Aluminum-Framed Entrances and Storefronts"**
- 3. **Division 08 Section "Flush Wood Doors"**
- 4. **Division 08 Section "Access Doors and Frames"**
- 5. **Division 08 Section "Overhead Coiling Doors"**
- 6. **Division 26 Sections for connections to electrical power system and for low-voltage wiring work.**
- 7. **Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access system.**
- 8. **Division 28 Section "Intrusion Detection" for detection devices installed at door openings and provided as part of an intrusion detection system.**

- C. **Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.**

- 1. **Thresholds, weather stripping, and cylinders for locks specified in other Sections.**

1.3 REFERENCED STANDARDS

- A. Provide hardware in accordance with the following standards in addition to those specified in Division 01 Section "References".

- 1. American National Standards Institute (ANSI), A117.1: Accessible and Usable Buildings and Facilities, edition as adopted by local Authority Having Jurisdiction (AHJ).

2. Builders Hardware Manufacturer's Association (BHMA)
 - a. ANSI/BHMA A156.2: Bored and Preassembled Locks and Latches, 2011 edition
 - b. ANSI/BHMA A156.3: Exit Devices, 2008 edition
 - c. ANSI/BHMA A156.4: Door Controls - Closers, 2008 edition
 - d. ANSI/BHMA A156.18: Materials and Finishes, 2006 edition
3. Door and Hardware Institute (DHI)
 - a. Recommended Locations for Architectural Hardware for Flush Wood Doors, 1993 edition
 - b. Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames, 2004 edition
 - c. Installation Guide for Doors and Hardware, 1994 edition
 - d. Keying Systems and Nomenclature, 2003 edition
 - e. Sequence and Format for the Hardware Schedule, 2001 edition
4. National Fire Protection Association (NFPA)
 - a. NFPA 70: National Electrical Code, edition as adopted by local AHJ.
 - b. NFPA 80: Standard for Fire Doors and Other Opening Protectives, edition as adopted by local AHJ.
 - c. NFPA 252: Standard Methods of Fire Tests of Door Assemblies, edition as adopted by local AHJ.

1.4 SUBMITTALS

- A. **Product Data:** Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. **Shop Drawings:** Details of electrified door hardware, indicating the following:
 1. **Wiring Diagrams:** Power, signal, and control wiring. Include the following:
 - a. System schematic.
 - b. Point-to-point wiring diagram.
 - c. Riser diagram.
 - d. Elevation of each door.
 2. Detail interface between electrified door hardware and fire alarm, access control, security, building control system.
 3. **Operation Narrative:** Describe the operation of doors controlled by electrified door hardware.
- C. **Samples for Verification:** For exposed door hardware of each type, in specified finish, full size. Tag with full description for coordination with the door hardware sets. Submit Samples before, or concurrent with, submission of the final door hardware sets, if requested.
 1. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

- D. **Qualification Data:** For Installer
- E. **Product Test Reports:** Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for locks, latches, and closers as requested.
- F. **Maintenance Data:** For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.
- G. **Warranty:** Special warranty specified in this Section.
- H. **Door Hardware Sets:** Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
 - 2. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, and material of each door and frame.
 - b. Type, style, function, size, quantity, and finish of each door hardware item.
 - c. Complete designations of every item required for each door or opening including name and manufacturer.
 - d. Fastenings and other pertinent information.
 - e. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - f. Explanation of abbreviations, symbols, and codes contained in schedule.
 - g. Mounting locations for door hardware.
 - h. Door and frame sizes and materials.
 - i. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
 - j. Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.
 - k. List of related door devices specified in other Sections for each door and frame.
 - 3. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.
- I. **Keying Schedule:** Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** An employer of workers trained and approved by lock manufacturer.

1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
 2. Installer shall have warehousing facilities in Project's vicinity.
 3. Scheduling Responsibility: Preparation of door hardware and keying schedules.
 4. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
- C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
- D. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 and UBC Standard 7-2.
1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill.
- E. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner, Construction Manager, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant and Owner's Security Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 2. Preliminary key system schematic diagram.
 3. Requirements for key control system.
 4. Address for delivery of keys.
- G. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to Owner's Representative by registered mail or overnight package service.

1.7 COORDINATION

- A. Coordinate layout and installation of recessed hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. **Coordinate with aluminum entrance door supplier for door hardware installation.**
- D. **Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, access control system, security system, and building control system.**

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of **operators and** door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Three (3) years from date of Substantial Completion, except as follows:
 - a. **Continuous Hinges: Lifetime of Building**
 - b. **Grade 1 Cylindrical Locks: Ten (10) years from date of Substantial Completion.**
 - c. **Exit Devices: Three (3) years from date of Substantial Completion.**
 - d. **Manual Closers: Thirty (30) years from date of Substantial Completion.**

1.9 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. **Maintenance Service:** Beginning at Substantial Completion, provide six (6) months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hinges: Ives, Hager, Stanley, McKinney, Bommer
 - 2. Continuous Hinges: Ives, Stanley, Hager, McKinney, Pemko
 - 3. Operating Door Trim: Ives, Rockwood, Hager, Trimco
 - 4. Electric Strikes: Von Duprin, HES
 - 5. Locks and Latches: Schlage, Sargent,
 - 6. Hospital Latches: Glynn Johnson, ABH
 - 7. Cylinders and Cores: Schlage
 - 8. Exit Devices: Von Duprin, Sargent,
 - 9. Mechanical Door Closers: LCN, Sargent,
 - 10. Accessories and Trim: Ives, Rockwood
 - 11. Overhead Stops and Holders: Glynn Johnson, Rixson, ABH, Sargent
 - 12. Saddle and Panic Thresholds: Zero, National Guard, Pemko
 - 13. Weather Strip and Gasket: Zero, National Guard, Pemko
 - 14. Miscellaneous Hardware: Ives, Rockwood, Hager, Trimco
 - 15. Emergency Access Key Box: Knox, Inc
 - 16. Key Cabinet: Lund Equipment
- B. Substitutions submitted in compliance with Division 01 Section "Substitutions" requirements will be reviewed for conformance to basis of design.

2.2 SCHEDULED HARDWARE

- A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" at the end of this Section. Products are identified by using hardware designation numbers of the following:
 - 1. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one manufacturer is specified under the Article "Manufacturers" in Part 2 for each hardware type, the comparable product of one of the other manufacturers that complies with requirements.

2.3 MATERIALS AND FABRICATION

A. General

1. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect.
 - a. Manufacturer's identification will be permitted on rim of lock cylinders only.
2. Base Metals: Produce hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units for finish designations indicated.
3. Provide hardware manufactured to conform to published templates generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.

B. Fasteners

1. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Furnish stainless steel (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
2. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Use through bolts only as indicated in this section unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.4 HINGES

A. Acceptable Products:

- | | | | |
|----|-----------|--------|---------|
| 1. | Ives: | 5BB1 | 5BB1HW |
| 2. | Hager: | BB1279 | BB1168 |
| 3. | Stanley: | FBB179 | FBB168 |
| 4. | McKinney: | TB2714 | T4B3386 |
| 5. | Bommer: | BB5000 | BB5004 |

B. Requirements:

1. Quantity: Provide the following, unless otherwise indicated:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
2. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
3. Hinge Weight: As indicated in hardware sets.
4. Hinge Base Metal: Unless otherwise indicated, provide the following:

- a. Exterior Hinges: Stainless steel with stainless-steel pin.
 - b. Interior Hinges: Steel with steel pin.
 - c. **Hinges for Fire-Rated Assemblies: Steel with steel pin.**
5. Hinge Options: Where indicated in door hardware sets or on Drawings:
- a. Safety Stud: Designed for stud in one leaf to engage hole in opposing leaf.
 - b. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for out-swinging doors.
 - c. Corners: Square.
6. Fasteners: Comply with the following:
- a. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
 - b. Wood Screws: For wood doors and frames.
 - c. **Threaded-to-the-Head Wood Screws: For fire-rated wood doors.**

2.5 CONTINUOUS HINGES

A. Acceptable Products:

- | | | | |
|----|-----------|-----------|-----------|
| 1. | Ives: | 112HD | 224HD |
| 2. | Stanley: | 661HD | 662HD |
| 3. | Hager: | 780-112HD | 780-224HD |
| 4. | McKinney: | MCK-12HD | MCK-25HD |
| 5. | Pemko: | FMSLFHD | FMHD |

B. Requirements:

- 1. **Geared Continuous Hinges:** Shall utilize a single gear section for the door leaf and a separate gear section for the frame side of the door. Provide full mortise or surface applied hinge as scheduled in each set. Geared hinges are to be UL 10C tested and approved for 90 minutes.

2.6 OPERATING DOOR TRIM

A. Door Bolts

1. Acceptable Products:

- | | | | |
|----|-----------|-------------|-----------|
| a. | Ives: | FB358/FB458 | DP1/DP2 |
| b. | Rockwood: | 557/555 | 570 |
| c. | Hager: | 283D/282D | 280X |
| d. | Trimco: | 3915/3917 | 3910/3911 |

2. Requirements:

- a. Provide bolt model recommended by manufacturer for door material type.

- b. Provide 1 inch throw stainless steel bolt with 12 inch length unless otherwise scheduled in the sets.
- c. Provide a dust proof strike for bottom bolt at all locations where there is not a threshold.

B. Push Plates, Pull Plates, and Pulls

1. Acceptable Products:

- | | | | | | |
|----|-----------|------|---------|-------|----------|
| a. | Ives: | 8200 | 8305 | 8190 | 9190 |
| b. | Rockwood: | 70C | 111x70C | BF157 | BF15747 |
| c. | Hager: | 30S | 31J | 12 | 159D/V/B |
| d. | Trimco: | 1001 | 1018 | 1191 | 1730 |

2. Requirements:

- a. **Push Plate:** Provide 6 inch by 16 inch by .050 inch push plate constructed of stainless steel. Bevel all four edges.
- b. **Pull Plate:** Provide 4 inch by 16 inch by .050 inch push plate constructed of stainless steel, bevel all four edges. Provide 10 inch center to center (CTC) pull constructed of stainless steel with a diameter of 1 inch.
- c. **Offset Pull:** Provide 10 inch center to center (CTC) pull with a 4 inch offset constructed of stainless steel with a diameter of 1 inch.
- d. **Push bar:** Push bar shall be constructed of stainless steel with a diameter of 1 inch.
- e. **Push/Pull Bar:** Provide 10 inch center to center (CTC) pull with a 4 inch offset and door pull equal to door width less 3 inches. Push/pull bar shall be constructed of stainless steel with a diameter of 1 inch.

2.7 ELECTRIC STRIKES

A. Acceptable Products:

- 1. Von Duprin: 6300 Series
- 2. HES: 9000 Series

B. Requirements:

- 1. Provide electric strikes that are continuous duty rated without the use of external rectifiers.
- 2. Provide electric strikes with function (fail safe, fail secure) and power requirements as scheduled.
- 3. Where scheduled, provide electric strikes with monitor switches.

2.8 LOCKS AND LATCHES

A. General:

- 1. Lock Chassis: Shall be made from steel, with locking spindles of stainless steel.
- 2. Latch Bolt: Shall be constructed of stainless steel with 3/4 inch throw on mortise locks and 1/2 inch throw otherwise. Latch to be deadlocking on keyed functions.

3. Lever Trim: Shall be pressure cast brass, bronze, zinc, or steel with wrought rose design. Levers are to be solid with no voids or plastic inserts.
4. Fire Rating: Lock shall be listed for up to 3 hours.
5. Strike Plates: Provide ANSI 4-7/8 inch strike plates. At pairs of doors, provide strike with 7/8 inch flat lip. At single doors, provide round-lipped strike with lip length as required to minimally clear jamb and trim. Provide dust box at each strike location.

B. Grade 1 Bored Locks

1. Acceptable Products:

- a. Schlage: ND Series
- b. Sargent: 10 Line

2. Requirements:

- a. ANSI Grade: BHMA/ANSI A156.2, Series 4000, Grade 1.
- b. Door Prep: Provide lockset to install using a standard ANSI 161 door preparation.
- c. Anti-Rotation Plate: Provide lockset with a mechanically interlocked anti-rotation plate. Anti-Rotation teeth or "bite tabs" are not acceptable. Locks without any rotation prevention devices are not acceptable.
- d. Lever Return Springs: Provide each lever with compression type return springs that are easily accessible without dismantling the lock chassis. Locks utilizing tension or torsion lever return springs are unacceptable. Locks with internal springs that require dismantling the lock chassis are unacceptable.
- e. Lever Spindles: Provide lock with either milled or 1-piece deep drawn spindles. 2-piece interlocking stamped spindles are not acceptable.
- f. Multi-Functionality: Provide modular lockset with capability to convert to a new lock function by changing key cams.
- g. Vandal Resistant Lever: Where scheduled, provide lockset with lever that freely rotates even when locked to resist vandalism and abuse.

C. Hospital Locks

1. Acceptable Products:

- a. Glynn Johnson: HL-6 Series
- b. Trimco: 1500 Series
- c. ABH: 6000 Series

2. Requirements:

- a. Provide lock chassis type and function as scheduled.

2.9 CYLINDERS AND CORES

A. Acceptable Products:

1. Schlage: Primus

B. Requirements:

1. **Full Size Interchangeable Cylinders:** Provide cylinders of quantity and type and with the appropriate cam/tailpiece to be compatible with the locking hardware provided. Provide cylinder housings ready to accept 6-pin, Full-Size Interchangeable Cores (FSIC).
 - a. **Temporary Construction Keying:** Provide each cylinder housing and/or lock lever with keyed construction core during the construction period. Cores will remain property of the contractor and will be returned upon installation of owner's permanent key system.
 - b. **Permanent Cores:** Provide **factory keyed** cores that are **utility patented until at least 2029**. Provide cores with a **geographically exclusive factory-restricted keyway**. Ship cores directly to owner's representative. At substantial completion, accompany the owner's representative while replacing temporary construction cores with the owner's permanent key system.
2. **Keys:** Provide cylinder manufacturer's standard keys. Keys shall be shipped separate from cores directly to owner's representative. For estimating purposes, provide keys in the following quantities:
 - a. **Construction Control Keys:** 2 each
 - b. **Construction Change Keys:** 12 each
 - c. **Permanent Control Keys:** 2 each
 - d. **Split Key Voiding Keys:** 2 each
 - e. **Permanent Master Keys:** 2 each
 - f. **Permanent Change Keys:** 4 per core

2.10 EXIT DEVICES

A. Acceptable Products:

1. **Von Duprin:** 98Series
2. **Sargent:** 88 Series

B. Requirements:

1. **ANSI Grade:** BHMA/ANSI A156.3, Grade 1.
2. **Device Construction:**
 - a. Exit device(s) shall have a mechanism case constructed of **extruded aluminum or wrought stainless steel**, base plates constructed of **cold rolled or cast steel**, push pad of **extruded aluminum with stainless steel covering or wrought stainless steel**, and end caps with **flush mounted design**. At full-glass doors, provide exit devices with **no exposed fasteners or rivets visible through glass**. Where required by stile width, provide narrow-stile type device.
 - b. **Latchbolt:** Provide Pullman-type deadlocking latch bolts constructed of stainless steel. Where specified provide **high security Pullman-type latchbolt that collapses to be square faced under high pull forces**.
 - c. **Dogging Mechanism:** where dogging or latch-retraction options are not specifically scheduled for non-fire rated doors, provide device with a **hex-key** activated dogging mechanism.
 - d. **Sound Dampening:** Device shall be provided with factory-installed sound dampening materials.

- e. Provide device type, function, and trim style as indicated in hardware schedules.
- 3. Where exit device(s) are provided for fire rated door, provide with fire listing and label indicating "Fire Exit Hardware". If device is mounted on wood doors, provide sex nuts and bolts.
- 4. Provide shim kits, filler plates, and other accessories as required for each opening.
- 5. Unless otherwise indicated in the sets, provide device with roller-type strike.
- 6. Where scheduled, provide removable mullions by same manufacturer as provided exit devices. Provide mullion stabilizers, key removable option, strike preps, and fire rating as indicated in sets.

2.11 MECHANICAL DOOR CLOSERS

A. General:

- 1. Valves: Closers shall have separate valves for latch speed, main speed, and back check. Valves shall be staked to prevent accidental removal. Provide the appropriate closer body, handing, and brackets to mount closer inside the building on the least-public side of the door.
 - a. Where closers are to be mounted parallel arm, provide with heavy duty, fully forged arms.
 - b. Where closers are to be mounted regular arm and the opening can otherwise be opened to 180 degrees, provide closer with the appropriate special templating to allow 180 degree door swing. Where a special template is not available for 180 degree swing, provide closer arm with integrated stop.
- 2. Integrated Stop Closer Arms: Where a closer with integrated stop is required, provide the appropriate closer and arm as follows:
 - a. Parallel arm with spring-cushioned stop arm: Provide where door is otherwise able to open to 95 degrees and requires a parallel arm mount closer.
 - b. Parallel arm with dead stop arm: Provide where door is obstructed from opening to 95 degrees and requires a parallel arm mount closer.
 - c. Regular arm with push side surface-mounted overhead stop: Provide where door closer should mount on pull side of door.
- 3. Hold Open Arms: Provide closer arms with mechanical hold-opens as scheduled.
- 4. Provide closers with any special templates, brackets, plates, or other accessories required for interface with header, door, wall, and other hardware. Provide closers with screw packs containing thru-bolts, machine screws, and wood screws.
- 5. Closers shall be provided with all-weather fluid and shall not require readjustment from 120 degrees F to -30 degrees F. Fluid shall be non-flaming and shall not fuel door or floor covering fires. Upon request, provide data indicating thermal properties of fluid.
- 6. Closers shall close and latch door when adjusted to meet accessibility requirements for door opening force: 8.5 lbs at exterior doors, 5 lbs at interior doors, and 15 lbs at labeled fire doors.

B. Heavy Duty Door Closers:

- 1. Acceptable Products:

- a. LCN: 4040XP
 - b. Sargent: 281
2. Requirements:
- a. ANSI Grade: BHMA/ANSI A156.4, Grade 1.
 - b. Closer Construction: Closer shall have cast iron or aluminum alloy body with 1-1/2 inch steel piston, double heat treated pinion, 5/8 inch bearing journals, and full complement needle or caged ball bearings. Closer shall be adjustable from sizes 1 through 6.
 - c. Provide closers with spring size adjustment dial for ease of adjusting.

2.12 ARCHITECTURAL DOOR TRIM

A. Protection Plates and Edge Guards

1. Acceptable Products:
- a. Ives: 8400 Series
 - b. Rockwood: K1050
 - c. Hager: 194S
 - d. Trimco: K Series
2. Requirements:
- a. Provide .050 inch thick stainless steel protection plates with height as scheduled. Plate shall have four beveled edges and countersunk screws. Provide plate with width as follows:
 - 1) Pairs of Doors: Provide plate to be 1 inch less door width.
 - 2) Single Doors: Provide plate to be 2 inches less door width on push side, pull side mounted plates to be 1 inch less door width.
 - 3) Where Specified with Edge Guards: Provide plate to be 2 inches less door width.

B. Door Stops and Holders

1. Acceptable Products:
- a. Ives: WS407
 - b. Rockwood: 405/406
 - c. Hager: 236W
 - d. Trimco: 1270
2. Requirements:
- a. Provide stops and holders as indicated in the HW sets.
 - b. Where wall bumpers are scheduled, provide concave rubber bumper where the adjacent lever trim incorporates a push-button. Otherwise, provide convex rubber bumpers.

2.13 OVERHEAD STOPS AND HOLDERS

A. Acceptable Products:

- | | | | |
|----|------------------|-------------|-------------|
| 1. | Glynn Johnson: | 100 Series | 90 Series |
| 2. | Rixson-Firemark: | 6 Series | 9 Series |
| 3. | ABH: | 1000 Series | 9000 Series |
| 4. | Sargent: | 100 Series | 90 Series |

B. Requirements:

1. Provide overhead stops and holders as scheduled, sized per manufacturer's recommendations based on door width.
2. Provide concealed overhead stops with adjustable jamb bracket.
3. Where possible without conflicting with other hardware, mount surface overhead stops on least public side of door.
4. Provide stops with any special templates, brackets, plates, or other accessories required for interface with header, door, wall, and other hardware.

2.14 SADDLE AND PANIC THRESHOLDS

A. Acceptable Products:

- | | | |
|----|---------------------|-------|
| 1. | Zero International: | 655A |
| 2. | National Guard: | 425HD |
| 3. | Pemko: | 1715A |

B. Requirements:

1. Saddle thresholds: Provide with length equal to the width of the opening.
2. Panic thresholds: Provide with length equal to the overall frame width. Provide with mitered and welded ends.
3. Where floor closers are scheduled with thresholds, provide threshold with factory cut outs to be compatible with the provided floor closer.
4. Provide stainless steel machine screws and lead anchors for each threshold.

2.15 WEATHERSTRIP AND GASKET

A. General:

1. Provide weather strip and gasketing as scheduled.
2. Size weather strip and gasket to provide a continuous seal around opening and at meeting stiles.

B. Perimeter Seals

1. Acceptable Products:

- | | | | | |
|----|-----------------|--------|--------|---------|
| a. | Zero: | 429A | 8303AA | 188S-BK |
| b. | National Guard: | 700SA | 160S | 5050B |
| c. | Pemko: | 2891AS | 303AS | S88D |

C. Door Bottoms

1. Acceptable Products:

- | | | | |
|----|-----------------|---------|----------|
| a. | Zero: | 8198AA | 39A |
| b. | National Guard: | C627A | 601 |
| c. | Pemko: | 3452CNB | 18100CNB |

2.16 MISCELLANEOUS HARDWARE

A. Silencers

1. Acceptable Products:

- | | | |
|----|-----------|-------|
| a. | Ives: | SR64 |
| b. | Rockwood: | 608 |
| c. | Hager: | 307D |
| d. | Trimco: | 1229A |

2. Requirements:

- a. Where indicated on single openings, provide 3 each rubber silencers on lock jamb.
- b. Where indicated on paired openings, provide 2 each rubber silencers on header.

2.17 HIGH SECURITY EMERGENCY KEY BOX

A. Acceptable Products:

1. Knox, Inc. 3200 Series x RMK

B. Requirements:

1. Provide recess-mounted emergency key box as approved by the local fire jurisdiction. Key box to be master-keyed as dictated by local fire jurisdiction.

2.18 KEY CONTROL CABINET

A. Acceptable Products:

1. Lund, Inc. 1200 Series

B. Requirements:

1. Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet.
2. Provide complete cross-index system set up by Owner, and place keys on markers and hooks in the cabinet as determined by the final key schedule.
3. Provide hinged-panel type cabinet for wall mounting with capacity for 250 unique keys.

2.19 FINISHES

- A. Match items to the manufacturer's standard color and texture finish for the latch and locksets (or push-pull units if no latch or locksets).
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- C. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.
- D. The designations used in schedules and elsewhere to indicate hardware finishes are the industry-recognized standard commercial finishes, except as otherwise noted.
 - 1. **Brushed Chrome and/or Stainless Steel Appearance**
 - a. Brushed Stainless Steel, no coating: ANSI 630.
 - b. Satin Chrome, Clear Coated: ANSI 626, ANSI 652.
 - c. Powder Coated Aluminum finish: ANSI 689.
 - d. Saddle and Panic Thresholds: Mill Aluminum finish.
 - e. Weatherstrip and Gasket: Clear Anodized Aluminum finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. [Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.](#)
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
 - 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.
- B. Wood Doors: Comply with DHI A115-W Series.

3.3 INSTALLATION

- A. Pre-installation conference shall be conducted prior to installation of hardware at Project site. Meet with the, Owner, Contractor, installer, and manufacturer's representatives. A separate pre-installation conference shall be conducted prior to the installation of electronic security hardware with the electrical contractor Review catalogs, brochures, templates, installation instructions, and the approved hardware schedule. Survey installation procedures and workmanship, with special emphasis on unusual conditions, as to ensure correct technique of installation, and coordination with other work. Notify participants at least ten, 10 working days before conference.
- B. Hardware Installers must have a minimum of **five (5)** years' experience in installation of hardware. Provide verification of installer's qualification to Consultant for approval. All installers to attend review meetings with the hardware distributor.
- C. Install hardware using only manufacturer supplied and approved fasteners in strict adherence with manufacturers published installation instructions.
- D. Install head seal prior to installation of "PA"-parallel arm mounted door closers and push side mounted door stops/holders. Trim, cut and notch thresholds and saddles neatly to minimally fit the profile of the door frame. Install thresholds and saddles in a bed of caulking completely sealing the underside from water and air penetration.
- E. Counter sink through bolt of door pull under push plate during installation.
- F. Mounting Heights: Mount door hardware units at heights indicated, as follows, unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
 - 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- G. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- H. Furnish wiring diagrams to electrical contractor for use in installing electrical hardware products.
 - 1. Electrical contractor to run all wiring and make all final connections for electrified hardware. Hardware supplier shall be responsible to furnish all wiring diagrams to operate electrified hardware. Access control material and electrified hardware to interface at junction boxes.

- I. **Thresholds:** Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

3.4 FIELD QUALITY CONTROL

- A. Architectural Hardware Consultant: Architect shall engage a qualified Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
- B. Architectural Hardware Consultant shall inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 1. **Electric Strikes:** Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 2. **Door Closers:** Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

3.8 DOOR HARDWARE SETS

- A. The following schedule of hardware sets shall be considered a guide and the supplier is cautioned to refer to general conditions, special conditions, and the full requirements of this section. It shall be the hardware supplier's responsibility to furnish all required hardware.
- B. Where items of hardware are not definitely or correctly specified and are required for completion of the Work, a written statement of such omission, error, conflict, or other discrepancy shall be sent to the Architect, prior to date specified for receipt of bids, for clarification by addendum.
- C. Adjustments to the Contract Sum will not be allowed for omissions or items of hardware not clarified prior to bid opening.

HW SET NO: 01

HARDWARE	BY DOOR MFG	B/O
----------	-------------	-----

HW SET NO: 02

1 EA	CONT. HINGE	224HD	628	IVE
1 EA	PANIC HARDWARE	98-L-06	626	VON
1 EA	PRIMUS RIM	20-757	626	SCH
	CYLINDER			
1 EA	ELECTRIC STRIKE	6300 FSE	✈ 630	VON
1 EA	SURFACE CLOSER	4040XP SCUSH MC	MTL	LCN
			PC	
1 EA	CUSH SHOE SUPPORT	4040-30	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	SEAL	429A	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 03

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	ENTRANCE LOCK	ND53RD RHO	626	SCH
1 EA	SURFACE CLOSER	4040XP CUSH MC	689	LCN
1 EA	CUSH SHOE SUPPORT	4040-30	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	SEAL	429A	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

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BOISE, IDAHO

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HW SET NO: 04

3 EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	626	IVE
1 EA	STOREROOM LOCK	ND80RD RHO	626	SCH
1 EA	SURFACE CLOSER	4040XP MC	689	LCN
1 EA	WALL STOP	WS407CCV	630	IVE
1 EA	SEAL	429A	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 05

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	STOREROOM LOCK	ND80RD RHO	626	SCH
1 EA	SURFACE CLOSER	4040XP H MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 06

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	ENTRANCE LOCK	ND53RD RHO	626	SCH
1 EA	SURFACE CLOSER	4040XP H MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 07

1 EA	CONT. HINGE	224HD	628	IVE
1 EA	PUSH PLATE	8200 4" X 16"	630	IVE
1 EA	PULL PLATE	8305 10" 4" X 16"	630	IVE
1 EA	SURFACE CLOSER	4040XP EDA MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 08

1 EA	CONT. HINGE	224HD	628	IVE
1 EA	PUSH PLATE	8200 6" X 16"	630	IVE
1 EA	PULL PLATE	8305 10" 6" X 16"	630	IVE
1 EA	SURFACE CLOSER	4040XP H MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 09

6 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	MANUAL FLUSH BOLT	FB458 (TOP)	626	IVE
1 EA	PASSAGE SET	ND10S RHO	626	SCH
2 EA	OH STOP	90S J	630	GLY
2 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	SECURITY ASTRAGAL	43SP (INACTIVE LEAF, PUSH SIDE)	600	ZER
2 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 10

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	PRIVACY LOCK	ND40S RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 11

2 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	⚡ 626	IVE
1 EA	VANDL EU	ND96RDEU RHO	⚡ 626	SCH
	STOREROOM			
1 EA	SURFACE CLOSER	4040XP MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE
1 EA	CREDENTIAL READER	BY DIV 28	⚡	B/O
	POWER SUPPLY	BY DIV 28	⚡	B/O

CARD IN. USER PRESENTS CREDENTIAL, ELECTRIC LOCKSET LEVER RELEASES, USER OPENS DOOR TO ENTER.

BOISE CITY FIRE STATION #4
BOISE, IDAHO

FEBRUARY, 2016

HW SET NO: 12

3 EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	626	IVE
1 EA	PANIC HARDWARE	98-L-06	626	VON
1 EA	PRIMUS RIM CYLINDER	20-757	626	SCH
1 EA	ELECTRIC STRIKE	6300 FSE	✓ 630	VON
1 EA	SURFACE CLOSER	4040XP EDA MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 13

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	PRIVACY LOCK	ND40S RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEALS	188S	BLK	ZER
1 EA	DOOR SWEEP	39A	AL	ZER

HW SET NO: 14

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	PRIVACY LOCK	ND40S RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 15

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	ENTRANCE LOCK	ND53RD RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEALS	188S	BLK	ZER
1 EA	DOOR SWEEP	39A	AL	ZER

HW SET NO: 16

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	ENTRANCE LOCK	ND53RD RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 17

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	STOREROOM LOCK	ND80RD RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 18

3 EA	HW HINGE	5BB1HW 5 X 4.5 NRP	626	IVE
1 EA	STOREROOM LOCK	ND80RD RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 19

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	CLASSROOM LOCK	ND70RD RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 20

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	PASSAGE SET	ND10S RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 21

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	PASSAGE SET	ND10S RHO	626	SCH
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 22

3 EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	626	IVE
1 EA	PUSH/PULL LATCH	HL6 2 3/4" A (MOUNT AT 72" AFF)	626	GLY
1 EA	SURFACE CLOSER	4040XP MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

NOTE: SPECIAL LOCATION FOR LATCH AT 72" ABOVE FINISH FLOOR.

HW SET NO: A

1 EA	CONT. HINGE	112HD	628	IVE
1 EA	PANIC HARDWARE	98-L-06	626	VON
1 EA	PRIMUS RIM CYLINDER	20-757	626	SCH
1 EA	ELECTRIC STRIKE	6300 FSE	✓ 630	VON
1 EA	OH STOP	100S ADJ	630	GLY
1 EA	SURFACE CLOSER	4040XP EDAW/62G MC	689	LCN
1 EA	PA MOUNTING PLATE	4040-18PA	689	LCN
1 SET	PERIMETER SEALS	DOOR MFG STD		B/O
1 EA	THRESHOLD	DOOR MFG STD		B/O
1 EA	CREDENTIAL READER	BY DIV 28	✓	B/O
	POWER SUPPLY	BY DIV 28	✓	B/O

CARD IN. USER PRESENTS CREDENTIAL, ELECTRIC STRIKE KEEPER RELEASES, USER OPENS DOOR TO ENTER.

HW SET NO: B

2 EA	CONT. HINGE	112HD	628	IVE
1 EA	PANIC HARDWARE	CD-9849-EO	626	VON
1 EA	PANIC HARDWARE	CD-9849-NL-OP-110MD-626	626/6 26	VON
2 EA	PRIMUS MORT. CYL.	20-700 XQ11-949-114,112,134 (DOGGING)	626	SCH
1 EA	PRIMUS RIM CYLINDER	20-757	626	SCH
2 EA	90 DEG OFFSET PULL	8190HD 10" L	630	IVE
2 EA	OH STOP	100S ADJ	630	GLY
2 EA	SURFACE CLOSER	4040XP EDAW/62G MC	689	LCN
2 EA	PA MOUNTING PLATE	4040-18PA	689	LCN
1 SET	PERIMETER SEALS	DOOR MFG STD		B/O
1 EA	THRESHOLD	DOOR MFG STD		B/O

EXIT DEVICES MAY BE MECHANICALLY DOGGED BY CYLINDERS FOR PUSH/PULL OPERATION.

HW SET NO: C

1 EA	CONT. HINGE	112HD	628	IVE
1 EA	ENTRANCE LOCK	ND53RD RHO 14-048 2-3/8	626	SCH
1 EA	SURFACE CLOSER	4040XP HCUSH MC	MTL PC	LCN
1 EA	PA MOUNTING PLATE	4040-18PA	689	LCN
1 EA	CUSH SHOE SUPPORT	4040-30	689	LCN
1 EA	BLADE STOP SPACER	4040-61	689	LCN
1 SET	PERIMETER SEALS	DOOR MFG STD		B/O
1 EA	THRESHOLD	DOOR MFG STD		B/O

HW SET NO: D

2 EA	CONT. HINGE	112HD	628	IVE
2 EA	HEADER/THRESH BOLT	4015 X 4085	626	ADA
1 EA	DEADLOCK	MS1851S 1-1/8 BS	628	ADA
1 EA	MORTISE CYL TURN	09-900 118	626	SCH
1 EA	PRIMUS MORT. CYL.	20-766	626	SCH
2 SET	PUSH/PULL BAR	9190HD-10"-NO	630	IVE
2 EA	SURFACE CLOSER	4040XP HCUSH MC	689	LCN
2 EA	PA MOUNTING PLATE	4040-18PA	689	LCN
2 EA	CUSH SHOE SUPPORT	4040-30	689	LCN
2 EA	BLADE STOP SPACER	4040-61	689	LCN
1 SET	PERIMETER SEALS	DOOR MFG STD		B/O
1 EA	THRESHOLD	DOOR MFG STD		B/O

END OF SECTION

Door/Hardware Index

Mark #	HW Set #
100	B
101A	12
101B	07
101C	07
101D	A
102	20
103	20
104	14
105	15
106	14
107	15
108	14
110	13
111	13
112	13
113	13
114	17
115	13
116	13
117	13
118	13
119	13
120	16
121	13
122	14
123	17
125	11
126	18
127	20

Mark #	HW Set #
128	10
129	06
133	16
135A	01
135B	01
135C	01
135D	01
135E	01
135F	01
135G	02
136	08
137	08
138	09
139	04
140	09
141	05
143	21
202A	C
202B	03
203	22
204	20
205	14
206	17
207A	19
207B	19
208A	19
208B	D

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SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Commercial door hardware for the following:
 - a. Swinging doors.
 - b. Fire-rated swinging doors.
 - c. Other doors to the extent indicated.
 - 2. Cylinders for doors specified in other Sections.
 - 3. Electrified door hardware.
- B. Related Sections include the following:
 - 1. Division 08 Section "Hollow Metal Doors and Frames"
 - 2. Division 08 Section "Aluminum-Framed Entrances and Storefronts"
 - 3. Division 08 Section "Flush Wood Doors"
 - 4. Division 08 Section "Access Doors and Frames"
 - 5. Division 08 Section "Overhead Coiling Doors"
 - 6. Division 26 Sections for connections to electrical power system and for low-voltage wiring work.
 - 7. Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access system.
 - 8. Division 28 Section "Intrusion Detection" for detection devices installed at door openings and provided as part of an intrusion detection system.
- C. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
 - 1. Thresholds, weather stripping, and cylinders for locks specified in other Sections.

1.3 REFERENCED STANDARDS

- A. Provide hardware in accordance with the following standards in addition to those specified in Division 01 Section "References".

1. American National Standards Institute (ANSI), A117.1: Accessible and Usable Buildings and Facilities, edition as adopted by local Authority Having Jurisdiction (AHJ).
2. Builders Hardware Manufacturer's Association (BHMA)
 - a. ANSI/BHMA A156.2: Bored and Preassembled Locks and Latches, 2011 edition
 - b. ANSI/BHMA A156.3: Exit Devices, 2008 edition
 - c. ANSI/BHMA A156.4: Door Controls - Closers, 2008 edition
 - d. ANSI/BHMA A156.18: Materials and Finishes, 2006 edition
3. Door and Hardware Institute (DHI)
 - a. Recommended Locations for Architectural Hardware for Flush Wood Doors, 1993 edition
 - b. Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames, 2004 edition
 - c. Installation Guide for Doors and Hardware, 1994 edition
 - d. Keying Systems and Nomenclature, 2003 edition
 - e. Sequence and Format for the Hardware Schedule, 2001 edition
4. National Fire Protection Association (NFPA)
 - a. NFPA 70: National Electrical Code, edition as adopted by local AHJ.
 - b. NFPA 80: Standard for Fire Doors and Other Opening Protectives, edition as adopted by local AHJ.
 - c. NFPA 252: Standard Methods of Fire Tests of Door Assemblies, edition as adopted by local AHJ.

1.4 SUBMITTALS

- A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Details of electrified door hardware, indicating the following:
 1. Wiring Diagrams: Power, signal, and control wiring. Include the following:
 - a. System schematic.
 - b. Point-to-point wiring diagram.
 - c. Riser diagram.
 - d. Elevation of each door.
 2. Detail interface between electrified door hardware and fire alarm, access control, security, building control system.
 3. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.
- C. Samples for Verification: For exposed door hardware of each type, in specified finish, full size. Tag with full description for coordination with the door hardware sets. Submit Samples before, or concurrent with, submission of the final door hardware sets, if requested.

1. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.
- D. Qualification Data: For Installer
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for locks, latches, and closers as requested.
- F. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.
- G. Warranty: Special warranty specified in this Section.
- H. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
 2. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, and material of each door and frame.
 - b. Type, style, function, size, quantity, and finish of each door hardware item.
 - c. Complete designations of every item required for each door or opening including name and manufacturer.
 - d. Fastenings and other pertinent information.
 - e. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - f. Explanation of abbreviations, symbols, and codes contained in schedule.
 - g. Mounting locations for door hardware.
 - h. Door and frame sizes and materials.
 - i. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
 - j. Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.
 - k. List of related door devices specified in other Sections for each door and frame.
 3. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.

- I. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.
 1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
 2. Installer shall have warehousing facilities in Project's vicinity.
 3. Scheduling Responsibility: Preparation of door hardware and keying schedules.
 4. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
- C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
 1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
- D. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 and UBC Standard 7-2.
 1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill.
- E. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner, Construction Manager, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant and Owner's Security Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.

2. Preliminary key system schematic diagram.
 3. Requirements for key control system.
 4. Address for delivery of keys.
- G. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to Owner's Representative by registered mail or overnight package service.

1.7 COORDINATION

- A. Coordinate layout and installation of recessed hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Coordinate with aluminum entrance door supplier for door hardware installation.
- D. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, access control system, security system, and building control system.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of operators and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three (3) years from date of Substantial Completion, except as follows:
 - a. Continuous Hinges: Lifetime of Building
 - b. Grade 1 Cylindrical Locks: Ten (10) years from date of Substantial Completion.
 - c. Exit Devices: Three (3) years from date of Substantial Completion.
 - d. Manual Closers: Thirty (30) years from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, provide six (6) months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Hinges: Ives, Hager, Stanley, McKinney, Bommer
 2. Continuous Hinges: Ives, Stanley, Hager, McKinney, Pemko
 3. Operating Door Trim: Ives, Rockwood, Hager, Trimco
 4. Electric Strikes: Von Duprin, HES
 5. Locks and Latches: Schlage, Sargent,
 6. Hospital Latches: Glynn Johnson, ABH
 7. Cylinders and Cores: Schlage
 8. Exit Devices: Von Duprin, Sargent,
 9. Mechanical Door Closers: LCN, Sargent,
 10. Accessories and Trim: Ives, Rockwood
 11. Overhead Stops and Holders: Glynn Johnson, Rixson, ABH, Sargent
 12. Saddle and Panic Thresholds: Zero, National Guard, Pemko
 13. Weather Strip and Gasket: Zero, National Guard, Pemko
 14. Miscellaneous Hardware: Ives, Rockwood, Hager, Trimco
 15. Emergency Access Key Box: Knox, Inc
 16. Key Cabinet: Lund Equipment
- B. Substitutions submitted in compliance with Division 01 Section "Substitutions" requirements will be reviewed for conformance to basis of design.

2.2 SCHEDULED HARDWARE

- A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" at the end of this Section. Products are identified by using hardware designation numbers of the following:
1. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one manufacturer is specified under the Article "Manufacturers" in Part 2 for each hardware type, the comparable product of one of the other manufacturers that complies with requirements.

2.3 MATERIALS AND FABRICATION

- A. General
1. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect.
 - a. Manufacturer's identification will be permitted on rim of lock cylinders only.
 2. Base Metals: Produce hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units for finish designations indicated.
 3. Provide hardware manufactured to conform to published templates generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.
- B. Fasteners
1. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Furnish stainless steel (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
 2. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Use through bolts only as indicated in this section unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.4 HINGES

- A. Acceptable Products:
1. Ives: 5BB1 5BB1HW

- | | | | |
|----|-----------|--------|---------|
| 2. | Hager: | BB1279 | BB1168 |
| 3. | Stanley: | FBB179 | FBB168 |
| 4. | McKinney: | TB2714 | T4B3386 |
| 5. | Bommer: | BB5000 | BB5004 |

B. Requirements:

1. Quantity: Provide the following, unless otherwise indicated:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
2. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
3. Hinge Weight: As indicated in hardware sets.
4. Hinge Base Metal: Unless otherwise indicated, provide the following:
 - a. Exterior Hinges: Stainless steel with stainless-steel pin.
 - b. Interior Hinges: Steel with steel pin.
 - c. Hinges for Fire-Rated Assemblies: Steel with steel pin.
5. Hinge Options: Where indicated in door hardware sets or on Drawings:
 - a. Safety Stud: Designed for stud in one leaf to engage hole in opposing leaf.
 - b. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for out-swinging doors.
 - c. Corners: Square.
6. Fasteners: Comply with the following:
 - a. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
 - b. Wood Screws: For wood doors and frames.
 - c. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.

2.5 CONTINUOUS HINGES

A. Acceptable Products:

- | | | | |
|----|-----------|-----------|-----------|
| 1. | Ives: | 112HD | 224HD |
| 2. | Stanley: | 661HD | 662HD |
| 3. | Hager: | 780-112HD | 780-224HD |
| 4. | McKinney: | MCK-12HD | MCK-25HD |
| 5. | Pemko: | FMSLFHD | FMHD |

B. Requirements:

1. Geared Continuous Hinges: Shall utilize a single gear section for the door leaf and a separate gear section for the frame side of the door. Provide full mortise or surface

applied hinge as scheduled in each set. Geared hinges are to be UL 10C tested and approved for 90 minutes.

2.6 OPERATING DOOR TRIM

A. Door Bolts

1. Acceptable Products:

a.	Ives:	FB358/FB458	DP1/DP2
b.	Rockwood:	557/555	570
c.	Hager:	283D/282D	280X
d.	Trimco:	3915/3917	3910/3911

2. Requirements:

- Provide bolt model recommended by manufacturer for door material type.
- Provide 1 inch throw stainless steel bolt with 12 inch length unless otherwise scheduled in the sets.
- Provide a dust proof strike for bottom bolt at all locations where there is not a threshold.

B. Push Plates, Pull Plates, and Pulls

1. Acceptable Products:

a.	Ives:	8200	8305	8190	9190
b.	Rockwood:	70C	111x70C	BF157	BF15747
c.	Hager:	30S	31J	12	159D/V/B
d.	Trimco:	1001	1018	1191	1730

2. Requirements:

- Push Plate: Provide 6 inch by 16 inch by .050 inch push plate constructed of stainless steel. Bevel all four edges.
- Pull Plate: Provide 4 inch by 16 inch by .050 inch push plate constructed of stainless steel, bevel all four edges. Provide 10 inch center to center (CTC) pull constructed of stainless steel with a diameter of 1 inch.
- Offset Pull: Provide 10 inch center to center (CTC) pull with a 4 inch offset constructed of stainless steel with a diameter of 1 inch.
- Push bar: Push bar shall be constructed of stainless steel with a diameter of 1 inch.
- Push/Pull Bar: Provide 10 inch center to center (CTC) pull with a 4 inch offset and door pull equal to door width less 3 inches. Push/pull bar shall be constructed of stainless steel with a diameter of 1 inch.

2.7 ELECTRIC STRIKES

A. Acceptable Products:

1. Von Duprin: 6300 Series
2. HES: 9000 Series

B. Requirements:

1. Provide electric strikes that are continuous duty rated without the use of external rectifiers.
2. Provide electric strikes with function (fail safe, fail secure) and power requirements as scheduled.
3. Where scheduled, provide electric strikes with monitor switches.

2.8 LOCKS AND LATCHES

A. General:

1. Lock Chassis: Shall be made from steel, with locking spindles of stainless steel.
2. Latch Bolt: Shall be constructed of stainless steel with 3/4 inch throw on mortise locks and 1/2 inch throw otherwise. Latch to be deadlocking on keyed functions.
3. Lever Trim: Shall be pressure cast brass, bronze, zinc, or steel with wrought rose design. Levers are to be solid with no voids or plastic inserts.
4. Fire Rating: Lock shall be listed for up to 3 hours.
5. Strike Plates: Provide ANSI 4-7/8 inch strike plates. At pairs of doors, provide strike with 7/8 inch flat lip. At single doors, provide round-lipped strike with lip length as required to minimally clear jamb and trim. Provide dust box at each strike location.

B. Grade 1 Bored Locks

1. Acceptable Products:

- a. Schlage: ND Series
- b. Sargent: 10 Line

2. Requirements:

- a. ANSI Grade: BHMA/ANSI A156.2, Series 4000, Grade 1.
- b. Door Prep: Provide lockset to install using a standard ANSI 161 door preparation.
- c. Anti-Rotation Plate: Provide lockset with a mechanically interlocked anti-rotation plate. Anti-Rotation teeth or "bite tabs" are not acceptable. Locks without any rotation prevention devices are not acceptable.
- d. Lever Return Springs: Provide each lever with compression type return springs that are easily accessible without dismantling the lock chassis. Locks utilizing tension or torsion lever return springs are unacceptable. Locks with internal springs that require dismantling the lock chassis are unacceptable.
- e. Lever Spindles: Provide lock with either milled or 1-piece deep drawn spindles. 2-piece interlocking stamped spindles are not acceptable.
- f. Multi-Functionality: Provide modular lockset with capability to convert to a new lock function by changing key cams.

- g. Vandal Resistant Lever: Where scheduled, provide lockset with lever that freely rotates even when locked to resist vandalism and abuse.

C. Hospital Locks

1. Acceptable Products:

- a. Glynn Johnson: HL-6 Series
- b. Trimco: 1500 Series
- c. ABH: 6000 Series

2. Requirements:

- a. Provide lock chassis type and function as scheduled.

2.9 CYLINDERS AND CORES

A. Acceptable Products:

- 1. Schlage: Primus

B. Requirements:

- 1. Full Size Interchangeable Cylinders: Provide cylinders of quantity and type and with the appropriate cam/tailpiece to be compatible with the locking hardware provided. Provide cylinder housings ready to accept 6-pin, Full-Size Interchangeable Cores (FSIC).
 - a. Temporary Construction Keying: Provide each cylinder housing and/or lock lever with keyed construction core during the construction period. Cores will remain property of the contractor and will be returned upon installation of owner's permanent key system.
 - b. Permanent Cores: Provide factory keyed cores that are utility patented until at least 2029. Provide cores with a geographically exclusive factory-restricted keyway. Ship cores directly to owner's representative. At substantial completion, accompany the owner's representative while replacing temporary construction cores with the owner's permanent key system.
- 2. Keys: Provide cylinder manufacturer's standard keys. Keys shall be shipped separate from cores directly to owner's representative. For estimating purposes, provide keys in the following quantities:
 - a. Construction Control Keys: 2 each
 - b. Construction Change Keys: 12 each
 - c. Permanent Control Keys: 2 each
 - d. Split Key Voiding Keys: 2 each
 - e. Permanent Master Keys: 2 each
 - f. Permanent Change Keys: 4 per core

2.10 EXIT DEVICES

A. Acceptable Products:

1. Von Duprin: 98Series
2. Sargent: 88 Series

B. Requirements:

1. ANSI Grade: BHMA/ANSI A156.3, Grade 1.
2. Device Construction:
 - a. Exit device(s) shall have a mechanism case constructed of extruded aluminum or wrought stainless steel, base plates constructed of cold rolled or cast steel, push pad of extruded aluminum with stainless steel covering or wrought stainless steel, and end caps with flush mounted design. At full-glass doors, provide exit devices with no exposed fasteners or rivets visible through glass. Where required by stile width, provide narrow-stile type device.
 - b. Latchbolt: Provide Pullman-type deadlocking latch bolts constructed of stainless steel. Where specified provide high security Pullman-type latchbolt that collapses to be square faced under high pull forces.
 - c. Dogging Mechanism: where dogging or latch-retraction options are not specifically scheduled for non-fire rated doors, provide device with a hex-key activated dogging mechanism.
 - d. Sound Dampening: Device shall be provided with factory-installed sound dampening materials.
 - e. Provide device type, function, and trim style as indicated in hardware schedules.
3. Where exit device(s) are provided for fire rated door, provide with fire listing and label indicating "Fire Exit Hardware". If device is mounted on wood doors, provide sex nuts and bolts.
4. Provide shim kits, filler plates, and other accessories as required for each opening.
5. Unless otherwise indicated in the sets, provide device with roller-type strike.
6. Where scheduled, provide removable mullions by same manufacturer as provided exit devices. Provide mullion stabilizers, key removable option, strike preps, and fire rating as indicated in sets.

2.11 MECHANICAL DOOR CLOSERS

A. General:

1. Valves: Closers shall have separate valves for latch speed, main speed, and back check. Valves shall be staked to prevent accidental removal. Provide the appropriate closer body, handing, and brackets to mount closer inside the building on the least-public side of the door.
 - a. Where closers are to be mounted parallel arm, provide with heavy duty, fully forged arms.
 - b. Where closers are to be mounted regular arm and the opening can otherwise be opened to 180 degrees, provide closer with the appropriate special templating to

allow 180 degree door swing. Where a special template is not available for 180 degree swing, provide closer arm with integrated stop.

2. Integrated Stop Closer Arms: Where a closer with integrated stop is required, provide the appropriate closer and arm as follows:
 - a. Parallel arm with spring-cushioned stop arm: Provide where door is otherwise able to open to 95 degrees and requires a parallel arm mount closer.
 - b. Parallel arm with dead stop arm: Provide where door is obstructed from opening to 95 degrees and requires a parallel arm mount closer.
 - c. Regular arm with push side surface-mounted overhead stop: Provide where door closer should mount on pull side of door.
3. Hold Open Arms: Provide closer arms with mechanical hold-opens as scheduled.
4. Provide closers with any special templates, brackets, plates, or other accessories required for interface with header, door, wall, and other hardware. Provide closers with screw packs containing thru-bolts, machine screws, and wood screws.
5. Closers shall be provided with all-weather fluid and shall not require readjustment from 120 degrees F to -30 degrees F. Fluid shall be non-flaming and shall not fuel door or floor covering fires. Upon request, provide data indicating thermal properties of fluid.
6. Closers shall close and latch door when adjusted to meet accessibility requirements for door opening force: 8.5 lbs at exterior doors, 5 lbs at interior doors, and 15 lbs at labeled fire doors.

B. Heavy Duty Door Closers:

1. Acceptable Products:
 - a. LCN: 4040XP
 - b. Sargent: 281
2. Requirements:
 - a. ANSI Grade: BHMA/ANSI A156.4, Grade 1.
 - b. Closer Construction: Closer shall have cast iron or aluminum alloy body with 1-1/2 inch steel piston, double heat treated pinion, 5/8 inch bearing journals, and full complement needle or caged ball bearings. Closer shall be adjustable from sizes 1 through 6.
 - c. Provide closers with spring size adjustment dial for ease of adjusting.

2.12 ARCHITECTURAL DOOR TRIM

A. Protection Plates and Edge Guards

1. Acceptable Products:
 - a. Ives: 8400 Series
 - b. Rockwood: K1050
 - c. Hager: 194S

- d. Trimco: K Series

2. Requirements:

- a. Provide .050 inch thick stainless steel protection plates with height as scheduled. Plate shall have four beveled edges and countersunk screws. Provide plate with width as follows:
- 1) Pairs of Doors: Provide plate to be 1 inch less door width.
 - 2) Single Doors: Provide plate to be 2 inches less door width on push side, pull side mounted plates to be 1 inch less door width.
 - 3) Where Specified with Edge Guards: Provide plate to be 2 inches less door width.

B. Door Stops and Holders

1. Acceptable Products:

- a. Ives: WS407
b. Rockwood: 405/406
c. Hager: 236W
d. Trimco: 1270

2. Requirements:

- a. Provide stops and holders as indicated in the HW sets.
b. Where wall bumpers are scheduled, provide concave rubber bumper where the adjacent lever trim incorporates a push-button. Otherwise, provide convex rubber bumpers.

2.13 OVERHEAD STOPS AND HOLDERS

A. Acceptable Products:

- | | | |
|---------------------|-------------|-------------|
| 1. Glynn Johnson: | 100 Series | 90 Series |
| 2. Rixson-Firemark: | 6 Series | 9 Series |
| 3. ABH: | 1000 Series | 9000 Series |
| 4. Sargent: | 100 Series | 90 Series |

B. Requirements:

1. Provide overhead stops and holders as scheduled, sized per manufacturer's recommendations based on door width.
2. Provide concealed overhead stops with adjustable jamb bracket.
3. Where possible without conflicting with other hardware, mount surface overhead stops on least public side of door.
4. Provide stops with any special templates, brackets, plates, or other accessories required for interface with header, door, wall, and other hardware.

2.14 SADDLE AND PANIC THRESHOLDS

A. Acceptable Products:

- | | | |
|----|---------------------|-------|
| 1. | Zero International: | 655A |
| 2. | National Guard: | 425HD |
| 3. | Pemko: | 1715A |

B. Requirements:

1. Saddle thresholds: Provide with length equal to the width of the opening.
2. Panic thresholds: Provide with length equal to the overall frame width. Provide with mitered and welded ends.
3. Where floor closers are scheduled with thresholds, provide threshold with factory cut outs to be compatible with the provided floor closer.
4. Provide stainless steel machine screws and lead anchors for each threshold.

2.15 WEATHERSTRIP AND GASKET

A. General:

1. Provide weather strip and gasketing as scheduled.
2. Size weather strip and gasket to provide a continuous seal around opening and at meeting stiles.

B. Perimeter Seals

1. Acceptable Products:

- | | | | | |
|----|-----------------|--------|--------|---------|
| a. | Zero: | 429A | 8303AA | 188S-BK |
| b. | National Guard: | 700SA | 160S | 5050B |
| c. | Pemko: | 2891AS | 303AS | S88D |

C. Door Bottoms

1. Acceptable Products:

- | | | | |
|----|-----------------|---------|----------|
| a. | Zero: | 8198AA | 39A |
| b. | National Guard: | C627A | 601 |
| c. | Pemko: | 3452CNB | 18100CNB |

2.16 MISCELLANEOUS HARDWARE

A. Silencers

1. Acceptable Products:

- | | | |
|----|-----------|-------|
| a. | Ives: | SR64 |
| b. | Rockwood: | 608 |
| c. | Hager: | 307D |
| d. | Trimco: | 1229A |

2. Requirements:

- a. Where indicated on single openings, provide 3 each rubber silencers on lock jamb.
- b. Where indicated on paired openings, provide 2 each rubber silencers on header.

2.17 HIGH SECURITY EMERGENCY KEY BOX

A. Acceptable Products:

1. Knox, Inc. 3200 Series x RMK

B. Requirements:

1. Provide recess-mounted emergency key box as approved by the local fire jurisdiction.
Key box to be master-keyed as dictated by local fire jurisdiction.

2.18 KEY CONTROL CABINET

A. Acceptable Products:

1. Lund, Inc. 1200 Series

B. Requirements:

1. Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet.
2. Provide complete cross-index system set up by Owner, and place keys on markers and hooks in the cabinet as determined by the final key schedule.
3. Provide hinged-panel type cabinet for wall mounting with capacity for 250 unique keys.

2.19 FINISHES

- A. Match items to the manufacturer's standard color and texture finish for the latch and locksets (or push-pull units if no latch or locksets).
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- C. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.
- D. The designations used in schedules and elsewhere to indicate hardware finishes are the industry-recognized standard commercial finishes, except as otherwise noted.
 1. Brushed Chrome and/or Stainless Steel Appearance

- a. Brushed Stainless Steel, no coating: ANSI 630.
- b. Satin Chrome, Clear Coated: ANSI 626, ANSI 652.
- c. Powder Coated Aluminum finish: ANSI 689.
- d. Saddle and Panic Thresholds: Mill Aluminum finish.
- e. Weatherstrip and Gasket: Clear Anodized Aluminum finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
 - 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.
- B. Wood Doors: Comply with DHI A115-W Series.

3.3 INSTALLATION

- A. Pre-installation conference shall be conducted prior to installation of hardware at Project site. Meet with the, Owner, Contractor, installer, and manufacturer's representatives. A separate pre-installation conference shall be conducted prior to the installation of electronic security hardware with the electrical contractor Review catalogs, brochures, templates, installation instructions, and the approved hardware schedule. Survey installation procedures and workmanship, with special emphasis on unusual conditions, as to ensure correct technique of installation, and coordination with other work. Notify participants at least ten, 10 working days before conference.
- B. Hardware Installers must have a minimum of five (5) years' experience in installation of hardware. Provide verification of installer's qualification to Consultant for approval. All installers to attend review meetings with the hardware distributor.
- C. Install hardware using only manufacturer supplied and approved fasteners in strict adherence with manufacturers published installation instructions.

- D. Install head seal prior to installation of "PA"-parallel arm mounted door closers and push side mounted door stops/holders. Trim, cut and notch thresholds and saddles neatly to minimally fit the profile of the door frame. Install thresholds and saddles in a bed of caulking completely sealing the underside from water and air penetration.
- E. Counter sink through bolt of door pull under push plate during installation.
- F. Mounting Heights: Mount door hardware units at heights indicated, as follows, unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
 - 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- G. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- H. Furnish wiring diagrams to electrical contractor for use in installing electrical hardware products.
 - 1. Electrical contractor to run all wiring and make all final connections for electrified hardware. Hardware supplier shall be responsible to furnish all wiring diagrams to operate electrified hardware. Access control material and electrified hardware to interface at junction boxes.
- I. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

3.4 FIELD QUALITY CONTROL

- A. Architectural Hardware Consultant: Architect shall engage a qualified Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
- B. Architectural Hardware Consultant shall inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 - 2. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

3.8 DOOR HARDWARE SETS

- A. The following schedule of hardware sets shall be considered a guide and the supplier is cautioned to refer to general conditions, special conditions, and the full requirements of this section. It shall be the hardware supplier's responsibility to furnish all required hardware.
- B. Where items of hardware are not definitely or correctly specified and are required for completion of the Work, a written statement of such omission, error, conflict, or other discrepancy shall be sent to the Architect, prior to date specified for receipt of bids, for clarification by addendum.
- C. Adjustments to the Contract Sum will not be allowed for omissions or items of hardware not clarified prior to bid opening.

HW SET NO: 01

HARDWARE	BY DOOR MFG		B/O
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HW SET NO: 02

1 EA	CONT. HINGE	224HD	628	IVE
1 EA	PANIC HARDWARE	98-L-06	626	VON
1 EA	PRIMUS RIM	20-757	626	SCH
	CYLINDER			
1 EA	ELECTRIC STRIKE	6300 FSE	✈ 630	VON
1 EA	SURFACE CLOSER	4040XP CUSH MC	689	LCN
1 EA	CUSH SHOE SUPPORT	4040-30	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	FLOOR STOP	FS18L	BLK	IVE
1 EA	SEAL	429A	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 03

1 EA	CONT. HINGE	224HD	628	IVE
1 EA	PUSH PLATE	8200 6" X 16"	630	IVE
		(VERIFY STILE WIDTH)		
1 EA	PULL PLATE	8305 10" 6" X 16"	630	IVE
		(VERIFY STILE WIDTH)		
1 EA	SURFACE CLOSER	4040XP EDA MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 04

3 EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	626	IVE
1 EA	STOREROOM LOCK	ND80RD RHO	626	SCH
1 EA	SURFACE CLOSER	4040XP SCUSH MC	689	LCN
1 EA	CUSH SHOE SUPPORT	4040-30	689	LCN
1 EA	SEAL	429A	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 05

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	STOREROOM LOCK	ND80RD RHO	626	SCH
1 EA	SURFACE CLOSER	4040XP H MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 06

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	ENTRANCE LOCK	ND53RD RHO	626	SCH
1 EA	SURFACE CLOSER	4040XP H MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 07

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1 EA	STOREROOM LOCK	ND80RD RHO	626	SCH
1 EA	SURFACE CLOSER	4040XP MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEALS	188S	BLK	ZER

HW SET NO: 08

1 EA	CONT. HINGE	224HD	628	IVE
1 EA	PUSH PLATE	8200 6" X 16"	630	IVE
1 EA	PULL PLATE	8305 10" 6" X 16"	630	IVE
1 EA	SURFACE CLOSER	4040XP H MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 09

6 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	MANUAL FLUSH BOLT	FB458 (TOP)	626	IVE
1 EA	PASSAGE SET	ND10S RHO	626	SCH
2 EA	OH STOP	90S J	630	GLY
2 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 SET	SEAL	8303AA	AL	ZER
1 EA	SECURITY ASTRAGAL	43SP (INACTIVE LEAF, PUSH SIDE)	600	ZER
2 EA	DOOR SWEEP	8198AA	AL	ZER
1 EA	THRESHOLD	655A MSLA-10	AL	ZER

HW SET NO: 10

1 SET	STRAP HANGER KIT	CRT-102 X SIZE AS REQ'D	630	KNC
1 SET	MORTISE LOCK & PULL	C-90L X C-90C X C-90T	626	KNC
1 EA	PRIMUS MORT. CYL.	20-700	626	SCH
1 EA	DECORATIVE PULL	8975 12" STD (KITCHEN SIDE)	628	IVE
	REMAINING HARDWARE	BY DOOR MFG		B/O

HW SET NO: 11

2 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	⚡ 626	IVE
1 EA	VANDL EU STOREROOM	ND96RDEU RHO	⚡ 626	SCH
1 EA	SURFACE CLOSER	4040XP MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE
1 EA	CREDENTIAL READER	BY DIV 28	⚡	B/O
	POWER SUPPLY	BY DIV 28	⚡	B/O

CARD IN. USER PRESENTS CREDENTIAL, ELECTRIC LOCKSET LEVER RELEASES, USER OPENS DOOR TO ENTER.

HW SET NO: 12

3 EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	626	IVE
1 EA	PANIC HARDWARE	98-L-06	626	VON
1 EA	PRIMUS RIM	20-757	626	SCH
	CYLINDER			
1 EA	ELECTRIC STRIKE	6300 FSE	✓ 630	VON
1 EA	SURFACE CLOSER	4040XP EDA MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 13

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	PRIVACY LOCK	ND40S RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
1 SET	SEALS	188S	BLK	ZER
1 EA	DOOR SWEEP	39A	AL	ZER

HW SET NO: 14

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	PRIVACY LOCK	ND40S RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 15

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	ENTRANCE LOCK	ND53RD RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 16

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	STOREROOM LOCK	ND80RD RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 17

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	CLASSROOM LOCK	ND70RD RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 18

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	PASSAGE SET	ND10S RHO	626	SCH
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 19

3 EA	HINGE	5BB1 4.5 X 4.5 NRP	626	IVE
1 EA	PASSAGE SET	ND10S RHO	626	SCH
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

HW SET NO: 20

3 EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	626	IVE
1 EA	PUSH/PULL LATCH	HL6 2 3/4" A (MOUNT AT 72" AFF)	626	GLY
1 EA	SURFACE CLOSER	4040XP MC	689	LCN
1 EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1 EA	WALL STOP	WS407CCV	630	IVE
3 EA	SILENCER	SR64	GY	IVE

NOTE: SPECIAL LOCATION FOR LATCH AT 72" ABOVE FINISH FLOOR.

HW SET NO: A

1 EA	CONT. HINGE	112HD	710	IVE
1 EA	PANIC HARDWARE	CD-98-NL-OP-110MD	711	VON
1 EA	PRIMUS MORT. CYL.	20-700 XQ11-949-114,112,134 (DOGGING)	643e	SCH
1 EA	PRIMUS RIM CYLINDER	20-757	643e	SCH
1 EA	90 DEG OFFSET PULL	8190HD 10" L	613	IVE
1 EA	SURFACE CLOSER	4040XP CUSH MC	693	LCN
1 EA	PA MOUNTING PLATE	4040-18PA	693	LCN
1 EA	CUSH SHOE SUPPORT	4040-30	693	LCN
1 EA	BLADE STOP SPACER	4040-61	693	LCN
1 SET	PERIMETER SEALS	DOOR MFG STD		B/O
1 EA	THRESHOLD	DOOR MFG STD		B/O

EXIT DEVICES MAY BE MECHANICALLY DOGGED BY CYLINDERS FOR PUSH/PULL OPERATION.

HW SET NO: B

2 EA	CONT. HINGE	112HD	710	IVE
2 EA	HEADER/THRESH BOLT	4015 X 4085	313	ADA
1 EA	DEADLOCK	MS1851S 1-1/8 BS	313	ADA
1 EA	MORTISE CYL TURN	09-900 118	643e	SCH
1 EA	PRIMUS MORT. CYL.	20-766	643e	SCH
2 SET	PUSH/PULL BAR	9190HD-10"-NO	613	IVE
2 EA	SURFACE CLOSER	4040XP MC	693	LCN
2 EA	PA MOUNTING PLATE	4040-18PA	693	LCN
2 EA	BLADE STOP SPACER	4040-61	693	LCN
1 SET	PERIMETER SEALS	DOOR MFG STD		B/O
1 EA	THRESHOLD	DOOR MFG STD		B/O

HW SET NO: C

HARDWARE	BY DOOR MFG	B/O
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END OF SECTION

Door/Hardware Index

Mark #	HW Set #
100A	A
100B	12
101	14
102	02
104	15
105	13
106	14
107	16
108	13
109	13
110	13
111	13
112	04
113	16
114	13
115	13
116	13
117	13
118	02
119	13
120	18
121	11
122	06

Mark #	HW Set #
123	07
124	15
125	03
126A	03
126B	01
126C	01
126D	01
126E	01
126F	01
126G	01
129	08
130	08
131	05
133	09
134	19
201	19
202	14
203A	17
203B	B
205	C
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DIVISION 21 – FIRE SUPPRESSION

SECTION 210000 - FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. Specification Section 220000, Plumbing General Requirements, is to be included as part of this Section of the specification.

B. Work Included:

1. This section covers the work necessary to design and install a complete, satisfactory, and ready to operate wet pipe fire protection system for heated areas and dry pipe fire protection system for non-heated areas (areas subject to freezing). Hazard classification shall be as required by the State Fire Marshal, local City, IBC, IFI, and applicable NFPA Standards.

C. Qualifications of Installer:

1. All work shall be performed by a qualified, competent, licensed Fire Sprinkler Contractor who can furnish a verified list of satisfactory installations of this type and size, for a period of 5 years or more. Fire sprinkler contractor shall be licensed by the Idaho State Fire Marshal, and shall have in his employ an Engineering Technician (Level III), certified by NICET (National Institute for Certification in Engineering Technologies).

D. System Responsibility:

1. All work required for the fire protection system, including design and installation, shall be the responsibility of the Fire Sprinkler Contractor. Coordination with other trades is critical. Contractor shall coordinate his work with all ductwork, piping, electrical, etc., to ensure that all systems can be installed with a minimum of interference. Sprinkler heads should be located in the center of ceiling tiles wherever and whenever possible. All piping penetrations through finished walls shall be provided with chrome escutcheons. Submittals which are required are only for the purpose of general coordination. Architect/Engineer assumes no responsibility or liability for the design of the system.
2. All monitoring of valves not shown on the electrical drawings shall be within the scope of work for the fire sprinkler contractor. This shall include, but not be limited to, the following: All conduit and wiring as required to monitor post indicator valves, tamper switches, and any other devices required to be supervised by the fire alarm panel. The sprinkler contractor shall also provide all power, wiring and conduit required for a complete and operational dry-pipe system (if required), unless such electrical is shown on the electrical drawings.

1.2 CODES AND STANDARDS:

- A. The sprinkler system is to be designed and installed in accordance with the latest applicable building codes, State and Local Fire Marshals requirements, and all applicable NFPA Standards.

PART 2 - PRODUCTS

2.1 SUBMITTALS:

- A. The Engineering Technician shall prepare and submit the following submittal data:
 - 1. Complete equipment list of all equipment to be installed, including manufacturer's name and catalog number.
 - 2. Layout drawing of complete sprinkler system indicating relationship of all other overhead items, including ductwork, lights, and structural members.
 - 3. Complete details and sections as required to clearly define and clarify the design.
 - 4. Plot plan indicating location of all underground connections, piping, valves, and related items.
 - 5. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable style or series number.
 - 6. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

2.2 MATERIALS AND EQUIPMENT:

- A. All materials shall be as specified below, or in accordance with applicable NFPA Standards:
 - 1. Piping shall be black steel per NFPA 13 requirements. Threadable, thin wall piping will not be allowed. CPVC is allowed for underground only.
 - 2. Fittings shall be 125 psi screwed cast or malleable iron for all threaded piping.
 - 3. Fittings shall be Victaulic FireLock®, Anvil Gruviok, Grinnell or Shurjoint fire protection products for all grooved or plain end piping. Couplings shall consist of two ductile iron housings conforming to ASTM A536, a pressure responsive elastomer gasket, and zinc electroplated carbon steel bolts and nuts. Rigid type or flexible type where necessary.
 - a. Rigid Type: Housings shall be cast to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's

- recommendations. Contractor shall remove and replace any improperly installed joints. 1 1/4" and Larger: Standard rigid joint equal to Victaulic FireLock® Style 009 or equal.
- b. Flexible Type: Use in seismic areas where required by NFPA 13, Victaulic Style 75 or 77 or equal.
- 4. Alarm valves or dry pipe valves shall be installed in system risers per local water purveyor requirements.
 - a. Alarm Check Valve: Black enamel coated ductile iron body, aluminum bronze clapper, stainless steel spring and shaft, brass seat, EPDM seal, and Nitrile seat o-rings with grooved end connections and waterflow detectors. Valve internal parts shall be replaceable without removing the valve from the installed position. Victaulic FireLock® Series 751 or equal.
 - b. Dry Pipe Valve: Low differential, latched clapper design, black enamel coated ductile iron body, aluminum bronze clapper, stainless steel spring and shaft, brass seat, EPDM diaphragm and seal, with Nitrile seat o-rings. Valve internal parts shall be replaceable without removing the valve from the installed position and be externally resettable. Valve shall be pre-trimmed with shut-off valve, 3-way ball valve, and actuator. Required air pressure is 13 psi with a maximum water pressure rating of 300 psi. Valve shall have grooved ends for vertical installation only.
 - 5. Butterfly control valves with supervisory tamper devices shall be installed for system control.
 - 6. All materials and equipment shall conform to the requirements of Underwriter Laboratories (UL) or Factory Mutual Global (FMG), and shall be so stamped.
 - 7. Pressure switches (water flow device) shall be installed in each system riser (dry pipe systems).
 - 8. Flow switches (water flow device) shall be installed in each system riser (wet pipe systems).
 - 9. Alarm Bell shall be 10-inch outdoor electric bell. Furnish for installation by the electrical contractor.
 - 10. Sway Bracing, both lateral and longitudinal, shall be required and shall be installed per applicable NFPA Standards.
 - 11. Fire Department Connection shall be provided for each system riser or manifold assembly. Install a 90 degree elbow with drain connection at each fire department connection to allow for system drainage to prevent freezing.
 - 12. Sprinkler heads shall be Reliable Designer Model F1, (or equal), recessed with screw-on type escutcheon, below finished ceilings. Where surface mounted obstructions are installed, two-piece escutcheons and pendent sprinklers may be used, if required. Where sprinkler heads are subject to damage such as the apparatus bay, adjacent equipment and storage rooms, and mechanical rooms all sprinkler heads shall be provided with protective covers. Escutcheons shall be listed, supplied, and approved for use with the sprinkler by the sprinkler

manufacturer. Where piping is exposed, install standard bronze upright or pendent sprinklers. Quick response dry sidewall sprinklers shall be used as required to comply with IBC requirements for exterior canopies.

13. Provide 12 extra sprinkler heads mounted together in a suitable cabinet. Include spares of all types of sprinklers installed in the building.
 14. Hangers, drains, and Inspectors Test Connections shall be installed in accordance with applicable NFPA Standards.
 15. Test and Drain Valve: Globe design valve providing test port with ½" integral orifice and drain port in one unit. Bronze body with copper alloy internals, polycarbonate sight glasses, Nitrile o-rings and EPDM valve seats.
 16. Back flow prevention as required by the State and Local Fire Marshall.
 17. Post indicator valves as required by the State and Local Fire Marshall, or as shown on plans.
 18. All piping penetrations through finished walls shall be provided with chrome escutcheons.
- B. Underground piping materials and installation shall comply with N.F.P.A. #24 and local water company specifications.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Upon completion of the system, secure the inspection of the required authorities and perform such tests as may be required to demonstrate compliance with local and state standards. Upon acceptance of the system by the inspecting authority, inform the Architect/Engineer in writing, showing proof of acceptance. Submit all required test certificates to required authorities.

3.2 INSTALLATION:

- A. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves and specialties shall be supplied by a single manufacturer. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by grooved pipe manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. Contractor's field personnel shall be properly trained in the installation of the manufacturer's grooved piping products. A Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
- B. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after

installation. Do not use any tools to remove bulb protectors.

END OF SECTION 210000

DIVISION 22 - PLUMBING

SECTION 220000 – PLUMBING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. The Bidding Requirements, Contract Requirements, and the General Requirements (Division 01) of these specifications shall govern all parts of the work.

B. Work Included:

1. Install work in accordance with these specifications and the accompanying plans. Furnish all labor, material, and equipment together with all incidental items not specifically shown or specified which are required by good practice to provide the complete plumbing systems as described.

C. Coordination and Site Visits:

1. This section of the work requires examination of and reference to all architectural, structural, utility, and electrical drawings for construction conditions that may affect the work. Inspect the building site and existing facilities for verification of existing conditions. Base all measurements from established benchmarks. Any discrepancy between actual measurements and those indicated, which prevents following good practices or the intent of the drawings and specifications, shall be reported to the Architect/Engineer, and work halted until instructions are received from the Architect/Engineer.

1.2 CODES, PERMITS, FEES:

- A. Install all work in accordance with applicable codes and standards. Obtain all required permits; pay all required fees including utility connections or extensions, in connection with this portion of the construction. Obtain all required certificates of inspection for the work.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP:

A. Materials:

1. All materials and equipment shall be of first quality, new, full size and weight, standard in every respect, and suitable for the space required. Use the same manufacturer for products

of similar class or service, such as valves and pumps. Protect all materials against loss, theft, or damage before and after installation.

2. Furnish and install all necessary foundations, supports, pads, bases, and piers required for all materials and equipment furnished under this contract.
3. Provide all required firestopping at piping penetrations of fire rated walls, floors, ceilings, and roofs. Firestopping shall be Dow Corning Fire Stop Sealant 2000 or Fire Stop Foam 2001, or approved equal.

B. Workmanship:

1. All materials and equipment shall be installed in a neat and workmanlike manner by competent specialists for each subtrade. Work shall be installed to the satisfaction of the Architect/Engineer with unsatisfactory work removed and reinstalled to his satisfaction at no extra cost to the Owner.
2. Provide all cutting and patching necessary to install the work specified in this section. Patching shall match adjacent surfaces. No structural members shall be cut without the approval of the Architect/Engineer. Provide all sleeves and inserts required before the floors and walls are built.
3. Locate all equipment that must be serviced in fully accessible positions. Provide clearance for removal of replacement parts and components, and with necessary couplings or flanges to remove the component for maintenance.

2.2 SUBMITTALS AND SUBSTITUTIONS:

A. Prebid Approval:

1. Manufacturer's trade names and catalog numbers stated herein are intended to indicate the quality of equipment or materials desired. All manufacturers not specifically listed require prior approval. Submit catalog data, including specifications, of the proposed equipment to the Architect/Engineer for his approval at least 10 calendar days prior to bid opening. Notice of such approvals will be published in an addendum. Approval of listed alternate equipment manufacturers is for bidding only. Final approval is to be based on requirements of the plans and specifications.

B. Submittals:

1. Within thirty days after award of this contract, provide six copies of a complete list of all materials and equipment proposed for this project. List shall contain make, type, manufacturer's name, and trade designation of all materials and equipment. Submittal shall also include manufacturer's complete specification for each item, including ratings, and dimensions as required to check space requirements. Provide six copies of all submittals. The scheduled equipment is the basis of design for physical size, etc. Alternate manufacturers shall not exceed the weight or physical size. Any changes to the Architectural, Structural and Mechanical systems due to alternate manufactures shall be the responsibility of the Contractor and Supplier. Submittals for fixtures, trim, and other

plumbing related items, requiring submittals, shall be submitted in a single complete package. Individual items will not be reviewed independently unless approved by the Engineer. Electronic submittals will be allowed when approved by the Architect and, or Owner. The requirements of electronic submittals are the same as those noted above.

2. Approval of submittals shall not relieve the contractor from responsibility for deviations from the plans or specifications, unless he has, in writing, called the Architect's /Engineer's attention to deviations at the time of submission, and obtained his written approval. Approval of submittals does not relieve the contractor from responsibility for errors in shop drawings or literature.

C. Equipment Requiring Submittals:

1. Plumbing Fixtures & Trim
2. Valves
3. Cast Iron Soil Piping
4. Pipe Stands
5. Air Compressor

PART 3 - EXECUTION

3.1 ACCESSIBILITY & SAFETY:

A. Accessibility:

1. All equipment which must be serviced or operated shall be located in fully accessible position. Minor changes from the drawings may be made to allow for better accessibility. All changes shall be approved prior to actual installation.
2. Access panels shall be provided if required for accessibility. Access panels to be steel, flanged, hinged doors by Cendrex, model AHD, or equal. Size as required for installation. Subcontractor shall furnish the required panels to the General Contractor and the required location for all access panels, unless otherwise specified in the Architectural specifications. Panels shall be installed by the General Contractor.

B. Safety:

1. No water piping shall run immediately over or within a 3-foot plan view clearance of any electrical panel or motor starter. Where piping must be located within these zones, install piping inside a conduit to prevent water access to electrical equipment.

3.2 COORDINATION:

- A. Coordinate all work with the various trades involved to provide a complete and satisfactory installation. The exact details of piping and equipment are not shown. No additional compensation will be made for offsets or relocation required in coordination with other trades.
- B. Alterations required due to improper supervision by the subcontractor shall be made at no extra cost, to the satisfaction of the Architect/Engineer.

3.3 EXCAVATION & BACKFILL:

- A. Excavate trenches required for underground piping to proper elevation and grade. Provide trenches with solid bottoms to allow support of piping along entire length with excavation at bells as required for jointing and inspection. Provide repairing of finished surfaces, and all required shoring, bracing, pumping, and protection for safety of persons and property. Observe all Local or State Safety Codes. Verify that elevations of existing utilities will allow for proper grading of piping connecting to existing utilities.
- B. Excavation and Backfill shall be in accordance with the requirements of Division 31, of these specifications.

3.4 IDENTIFICATION AND CODING:

- A. General:
 - 1. The Contractor shall use ASME 13 standards for all piping identifications, color coding, and compliance.
- B. Painting:
 - 1. All painting of equipment, accessories, and piping shall be furnished and applied under the Architectural section of these specifications. All painting shall be completed before any identification markings are applied.
- C. Piping:
 - 1. Identify all piping as to the service of the pipe and the direction of flow. The letters shall be 3/4 inch high on piping two inches or smaller, and 1-1/4 inches high on piping up to six inches. Flow arrows shall be at least six inches long. The letters and flow arrows shall be made by precut stencils and oil base paint, one inch high and black, or factory fabricated plastic pipe markers. Piping shall be identified at 25 foot maximum intervals, on long continuous lines; adjacent to each item of equipment; on each riser and junction, and on both sides of all wall penetrations. Underground piping shall be identified with bright colored continuously printed plastic tape of not less than 6" wide by 4 mil thick, manufactured for direct burial service. Install directly above all buried pipe, 6 to 8 inches below finished grade.
- D. Valves:
 - 1. Regardless of size, all valves shall be tagged with a numbered brass tag, 1-1/2 inches by 3

inches minimum in size and 0.051 inch thick. A valve chart indicating valve tag number, location, service, and normal position shall be mounted in a suitable framed and glassed cover in the main mechanical room or as directed. Valve chart shall be duplicated in the Maintenance and Operations Manual.

3.5 TESTING:

A. Piping:

1. All plumbing piping (drainage, water, gas) shall be tested in accordance with the requirements of the Idaho State Plumbing Code, latest edition. Other piping systems shall be tested hydrostatically to 1.5 times the operating pressure but not less than 100 psi, for a minimum period of two hours. If the test pressure falls more than 5 percent during the test period, the leak shall be located, repaired, and the test repeated.
2. Piping shall be tested before insulation has been installed. Delicate control mechanisms shall be removed during tests to prevent shock damage. The use of chemicals or compounds to stop leaks shall not be permitted.
3. A test report shall be submitted for each piping system test. Test report forms are part of Specifications Section 220100, or are available from the Engineer.

B. Systems:

1. All plumbing systems shall be tested at the completion of the building to establish that the systems operate as specified and required.

3.6 CLEANING AND ADJUSTING:

A. Thoroughly clean all parts of the system at the completion of the work. Flush all water circulating systems with fresh water and then drain. Clean all strainers and refill system. Adjust all devices for proper operation and lubricate all equipment as required. Repaint any painted surface that has been damaged.

B. All potable water systems shall be flushed and disinfected after tests are completed. Disinfection shall be in accordance with local municipal and State Plumbing Inspector's criteria. In lieu of such criteria, the following procedure shall be followed for disinfection:

1. Completely flush system. Add alkali or acid (hydrochloric) to bring water ph level to between 7.4 and 7.6.
2. Inject chlorine (liquid, powder, tablet, or gas) throughout the system to obtain 50 to 80 mg/L residual.
3. Bleed water from outlets to ensure distribution, and test for residual at a minimum of 15 percent of the outlets.
4. Maintain disinfection in system for 24 hours.

5. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
6. Flush disinfectant from system until residual is equal to that of incoming water, or 1.0 mg/L.
7. Take samples no sooner than 24 hours after flushing, from 10 percent of the outlets and the incoming water.

3.7 PROJECT CLOSEOUT:

A. Operations & Maintenance Manual:

The Contractor shall provide an operations and maintenance manual at least thirty days prior to completion of work. The manual shall be of the three ring binder type, entitled "Operations and Maintenance Manual", with the job name and year of completion also included. O & M manuals shall be submitted in a single package. Individual items will not be accepted independently unless approved by the Engineer. The manual shall include, as a minimum:

1. Maintenance instructions for all equipment, including lubrication requirements.
2. Fixture suppliers names, addresses, and telephone numbers.
3. Fixture catalog cuts, ratings tables, model numbers, serial numbers, and accessories.
4. Parts numbers for all replaceable parts.
5. Valve tagging chart as hereinbefore specified.
6. Guarantee letter as specified below.
7. Any additional information required to enable the Owner to properly maintain the building plumbing system.
8. After approval of the Operations and Maintenance Manual by the Architect/Engineer, the Contractor shall furnish two copies of the manual to the Owner.

B. As-Built-Drawings:

1. Provide two sets of blue-line mechanical drawings showing the work as it was actually installed. The drawings shall indicate all departures from the contract drawings, and shall locate all underground utility lines with dimensions from established building lines. Make all notations neat and legible, with red indelible pencil. At the completion of the work, these as-built drawings shall be signed and dated by the Plumbing Contractor, and returned to the Architect/Engineer.

C. Guarantee:

1. All work furnished under this section shall be guaranteed in writing to be free from defective work or materials for a period of one year after acceptance of the contract. All

repairs or replacements because of defective materials or workmanship or noncompliance with code shall be provided without additional cost to the Owner. Contractor shall furnish a letter indicating above guarantee with space for date of acceptance and expiration of guarantee. Letter shall be included in O & M Manual.

END OF SECTION 220000

SECTION 220100 - PLUMBING

PART 1 - GENERAL

1.1 SCOPE:

- A. This section covers the work necessary for the plumbing system, complete. The Plumbing General Requirements, Section 220000, are to be included as a part of this section of the specifications.

1.2 CODES:

- A. The plumbing system shall be installed in accordance with the Idaho State Plumbing Code, latest edition, International Fuel Gas Code, latest edition; and all local and State Codes.

1.3 FIXTURES & EQUIPMENT:

A. General:

1. Plumbing fixtures and equipment shall be as listed on the drawings. In addition to those specifically listed, the following manufacturers are approved for bidding only. All other manufacturers require prior approval. Final approval for installation is based on submittal data furnished:
 - a. Tank Type Water Closets: American Standard, Kohler, Eljer, Mansfield, Toto, Zurn, & Sloan.
 - b. Flush Valve Water Closets: American Standard, Kohler, Eljer, Mansfield, Toto, Zurn, Briggs, & Sloan.
 - c. Urinals: American Standard, Kohler, Eljer, Mansfield, Toto, Zurn, Briggs, Sloan, & Gerber.
 - d. Vitreous China Sinks: American Standard, Kohler, Eljer, Zurn, Mansfield, Crane, Sloan, & Toto.
 - e. Stainless Steel Sinks: Elkay, Just.
 - f. Faucets: American Standard, Kohler, Chicago Faucets, Delta, Moen, Geberit, T&S Brass, Gerber, CHG Encore Saniguard, Zurn Aquaspec, Symmonds, Sloan & AMTC.
 - g. Valves and Trim: T&S Brass, Dearborn Brass, Brasscraft, ProFlo, & Sloan.
 - h. Flush Valves: Sloan, Delany, Delta and Zurn, American Standard Selectronic, Kohler, Moen (sensor-operated only) & AMTC.
 - i. Carriers and Drainage Products: Jay R. Smith, Josam, Zurn, Wade, Watts, Neenah Foundry, NDS, & MIFAB.
 - j. Toilet Seats: Bemis, Church, Comfort Seats, Beneke, Zurn, American Standard, & Kohler.
 - k. Mixing Valves: Symmonds, Leonard, Powers, Watts, Wilkins, Lawler, Stingray, Acorn Controls.
 - l. Fiberglass/ Acrylic Fixtures: Best Bath, Praxis-Comfort Designs, Intersan, MAXX, Fiat, Aquatic, & Aquaglass, Swan.
 - m. Drinking Fountains/ Electric Water Coolers: Haws, Acorn Aqua, Oasis, Stern Williams, Halsey Taylor, Elkay, Sunroc.

- n. Safety Fixtures & Safety Mixing Valves: Haws, Gaurdian, Acorn, Bradley, Chicago Faucets, Encon, Lawler, Stingray, Speakman.
 - o. Security Fixtures: Acorn, Bradley, Willoughby.
 - p. Washfountains: Bradley, Acorn, Intersan, Willoughby.
 - q. Service Sinks: Fiat, Acorn, Stern Williams, Zurn, Proflo.
 - r. Water Heaters: Rheem, A.O. Smith, PVI, Bradford-White, American, Heat Transfer-Phoenix, Rinnai, Bock, & Navien.
 - s. Backflow Preventers: Watts, Conbraco/ Apollo, & Wilkins.
 - t. Hose Bibbs: Woodford, Josam, Zurn, J.R. Smith, Prier.
 - u. Trench Drains: J.R. Smith, ABT, Strongwell Polycast, ACO, Zurn, NDS, Wade.
 - v. Utility Sinks: Fiat, Proflo.
2. Plumbing Fixture Standards:
All plumbing fixtures shall meet or exceed the following standards:
- a. ANSI A112.6.1 - Supports for Off-the Floor Plumbing Fixtures for Public Use.
 - b. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
 - c. ANSI A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
 - d. ANSI A112.19.2 - Vitreous China Plumbing Fixtures.
 - e. ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
 - f. ANSI A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
 - g. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
 - h. ANSI Z124.1 - Gel-Coated Glass-Fiber Reinforced Polyester Resin Bathtub Units.
 - i. ANSI Z124.2 - Gel-Coated Glass-Fiber Reinforced Polyester Resin Shower Receptor and Shower Stall Units.
 - j. ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.
 - k. ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
 - l. AWSI/ASSE 1001 – Atmospheric Vacuum Breaker
 - m. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.
 - n. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
 - o. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
 - p. ANSI/ASSE 1015 – Backflow Preventers, Double Check Principle
 - q. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
 - r. AWSI/ASSE 1020 – Pressure Vacuum Breaker
 - s. AWSI/ASSE – 1-52 – Hose Connection, Double Check
 - t. ANSI A112.21.1 - Floor Drains.
 - u. ANSI A112.21.2 - Roof Drains.
 - v. ANSI A112.26.1 - Water Hammer Arresters.
 - w. PDI WH-201 - Water Hammer Arresters.
 - x. ANSI/AWWA C606 – Grooved and Shouldered Joints

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES & TRIM:

- A. All plumbing fixtures shall be provided complete with all required trim for a complete and operational system. All piping penetrations through finished walls shall be provided with chrome escutcheons. All plumbing fixtures shall be caulked and sealed to surrounding surfaces. All sink

traps shall be provided with a cleanout plug in the bottom of the trap. All interior exposed pipe, valves, and fixture trim shall be chrome plated, including kitchen compartment sinks. Braided stainless steel pipe risers are approved for concealed locations only, such as behind casework doors or lav shields. Each fixture shall be provided with stop valves and the stop valves shall be quarter-turn brass ball type. All fixtures and trim must be lead free. All floor drains and floor sinks shall be provided with trap primers (PPP, Zurn or Wade as needed for appropriate use. Provide ball valve type shut-off valve upstream of all trap primer valves).

2.2 PIPING AND FITTINGS:

A. General:

1. Underground sanitary sewer and storm drain lines shall be installed at 1/4" per foot slope, unless otherwise indicated. If such slope is not possible due to existing inverts, approval shall be obtained from the Architect/Engineer and the authority having jurisdiction before any piping is installed at a lesser slope.
2. Connections between piping of dissimilar materials shall be made with dielectric waterway fittings or unions.
3. Provide standard manufactured water hammer arresters at all flush valves. Size and locate per manufacturers recommendations. Provide access panels for access to all water hammer arresters.

B. Domestic & Non Potable Hot and Cold Water:

1. Piping inside building above slab or above grade in crawl space shall be ASTM B88, Type "L", hard drawn copper. Fittings shall be ANSI/ASME B16.22 cast brass, or ANSI/ASME B16.29 wrought copper. Joints shall be ANSI/ASTM B32 solder, Grade 95-5, lead free.
 - a. Cold Water Only Option- ANSI/ASME B16.18 cast bronze, or ANSI/ASME B16.22 wrought copper. Joints shall be copper-tube dimensioned grooved joint couplings, and Flush Seal style gasket. (Gasket shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Victaulic Style 606, Gruvlok style 6400, Grinnell Universal Tongue and Groove 672, Shurjoint C305, or equal.
2. Piping underground within 5 feet of the building line, smaller than 4 inches, shall be ASTM B88, Type "K", hard drawn copper. Piping below floor slab, smaller than 4 inches, shall be type "K", soft annealed copper. Fittings shall be ANSI/ASME B16.29 wrought copper. Joints shall be ANSI/ASTM B32 solder, Grade 95-5, lead free. No joints shall be installed beneath concrete floor slabs, unless approved by the Engineer. Underground or underslab copper piping shall be provided with a polyethylene jacket, ANSI/AWWA C105, or shall be wrapped with double layer, half-lapped, 10 mil polyethylene tape.
 - a. Underground (below slab) Piping Option- 1/2" to 4", High Density Polyethylene (HDPE) pressure pipe. ASTM D3350, ASTM D3035 & ASTM F714. AWWA C901 & AWWAC906, NSF. Fittings shall be HDPE, solvent weld. Piping shall be rated for not less than 150 psig.
 - b. Trap Primer Piping (below floor or concealed only) –
 - 1) 1/2" Wirsbo Aquapex Tubing or equal.

C. Sanitary Sewer and Vent:

1. Waste piping from the second floor – piping shall be cast iron CISPI 310, ASTM A888 hubless, with cast iron fittings. Standard Couplings shall be neoprene gaskets and stainless steel clamp-and-shield assemblies and shall conform to CSPI 310, ASTM C 1277, FM 1680, & IGC-237, and be listed NSF International. Heavy Duty Couplings shall conform to ASTM C 1540. Pipe and fittings shall be manufactured by AB&I, Charlotte, Tyler, or receive prior approval.
2. All other piping not noted above – piping and fittings shall be Schedule 40 PVC-DWV (cellular core), per ASTM F1488 and ASTM F891, solvent welded per solvent manufacturer's instructions, or ABS Schedule 40 piping and fittings per either ASTM D2661 or ASTM F628 with solvent cement conforming to ASTM D2235. All sewer risers (2 story or more) shall be service weight cast iron, no-hub or single-hub, ASTM A74. All piping penetrations through fire rated walls, floors, or ceilings, and all piping located above ceilings used as return air plenums shall also be cast iron or galvanized steel, ASTM A53. Underground PVC-DWV piping shall be installed per ASTM D-2321.
3. All 90 degree waste line elbows shall be formed per the latest issue of the Idaho State Plumbing Code, latest edition.
4. All flush valve fixtures that are installed back to back shall have offset waste outlet fittings.
5. Cleanouts shall be provided at each horizontal drainage pipe, at its upper terminal, and each run of piping which is more than 100 feet, and shall be provided for each 100 feet developed length, or fraction thereof of such piping. An additional cleanout shall be provided for each aggregate horizontal change of direction exceeding one hundred and thirty-five degrees, per applicable plumbing code. This shall be provided regardless of what is shown on the drawings.
6. All floor drains, floor sinks, and hub drains shall be installed with a trap primer.
 - a. Flush Valve Primer: Trap primer shall be Precision plumbing products model FVP-1VB with vacuum breaker.
 - b. Pressure Activated Primer: Trap primer shall be Precision plumbing products Model CPO-500 with DU distribution unit if required.
7. All vent's through roof (VTR'S) shall be extended at least 1 foot above the roof surface, or to the top of the closest adjacent parapet wall, whichever is greater.

D. Storm Drains:

1. Above grade piping shall be cast iron CISPI 301, ASTM888 hubless with cast iron fittings. Joints shall be neoprene gaskets and stainless steel clamp-and-shield assemblies, and shall conform to CISP 310, ASTM C 1277, FM 1680, & IGC-237. Heavy duty couplings shall conform to ASTM C 1540. Pipe and fittings shall be manufactured by AB&I, Charlotte, Tyler, or receive prior approval.
2. Below grade piping and fittings shall be Schedule 40 PVC-DWV (cellular core), per ASTM F1488 and ASTM F891, solvent welded per manufacturer's instructions, or ABS Schedule 40 piping and fittings per either ASTM D2661 or ASTM F628 with solvent cement conforming to ASTM D2235. All piping located above ceilings used as return air plenums, and all piping penetrations through fire rated walls, floors, or ceilings shall be service weight cast iron, ASTM888 no-hub or single hub, ASTM A74. Underground piping shall be installed per ASTM D-2321.

3. Cleanouts shall be provided at each horizontal drainage pipe, at its upper terminal, and each run of piping 2" size which is more than 50 feet and shall be provided for each 50 feet developed length. 4" size or larger which is more than 100 feet developed length, or fraction thereof of such piping. An additional cleanout shall be provided for each aggregate horizontal change of direction exceeding one hundred and thirty-five degrees, per applicable plumbing code. This shall be provided regardless of what is shown on the drawings. Final determination of cleanout spacing shall be per local jurisdiction and code requirements and shall be installed accordingly.

E. Compressed Air:

1. Piping shall be Schedule 40 black steel pipe, ASTM A53, with black banded 200 pound malleable iron fittings and couplings.

F. Natural Gas:

1. Piping shall be Schedule 40 black steel pipe, ASTM A53. Exposed fittings 2 inches and smaller shall be ANSI/ASME B16.3, screwed, black malleable iron.
2. Fittings larger than 2 inches and all underground fittings shall be Schedule 40 steel butt-welded type. Underground piping shall be provided with a polyethylene jacket, ANSI/AWWA C105, or shall be wrapped with double layer, half-lapped, 10 mil polyethylene tape.
 - a. Contractors Option for Underground Piping: Gastite Type PE flexible corrugated gas piping. NFPA-54 & 56. ASTM D2513 Category 1. ASME D-B31.8-1995.
3. All exterior piping exposed to the weather shall be coated with a rust inhibitor – Rustoleum #866 Pro-Guard Primer – red or gray color – or approved equal.

G. Condensate Drain Piping:

1. Exterior to building, or located in a plenum: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints. Copper piping shall not be used on 90% condensing type equipment.
2. Interior: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints, grade 95TA, or shall be schedule 40 PVC. Copper piping shall not be used on 90% condensing type equipment. Provide a neoprene or rubber gasket at all copper piping support hangers to inhibit corrosion.
 - a. Inside Mechanical Rooms: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints, grade 95TA, unless otherwise specified by the equipment manufacturer.

H. Hanger and Supports:

1. Pipe hangers shall be provided to adequately support all piping systems. Hangers shall be vertically adjustable to provide for proper pitch and drainage. Hangers shall allow for expansion and contraction of the piping system. Reference "General Regulations" of the latest edition of the Idaho State Plumbing Code, latest edition.
2. Hangers for pipe sizes 1/2 to 6 inches shall be adjustable clevis type, or unistrut saddles with all-thread hanger rod.

3. Hangers for hot pipe, sizes 6 inches and over shall be adjustable steel yoke, cast iron roll, double hanger type.
4. Vertical pipes shall be supported with steel riser clamps. Spacing interval requirements per "General Regulations" of the latest edition of the Idaho State Plumbing Code, latest edition.
5. All insulated piping shall be provided with minimum 18 gauge galvanized insulation shields, 12 inches long, and oversized hangers. Pipe sizes 2 inches and over shall also be provided with 12 inch long calcium silicate insulating blocks between the piping and the galvanized insulation shield.
 - a. Alternate: Insulated pipe support inserts may be provided at hanger, support, and guide locations on piping requiring insulation. The insert should consist of either Hydrous Calcium Silicate or Polyisocyanurate Foam insulation (Urethane) encircling the entire circumference of the pipe with a 360 deg. PVC (1.524 mm thick) or galvanized steel jacket and installed during the installation of the piping system. These insulated pipe support inserts shall be provided by the Mechanical Contractor and installed by the same during pipe support installation.
6. Hanger rod sizing and spacing for pipe shall be as follows:

Pipe Size	Minimum Rod Diameter	Maximum Spacing
To 1-1/4 inches	3/8 inch	6.5 feet
To 2 inches	3/8 inch	10 feet
To 3 inches	1/2 inch	10 feet
To 6 inches	5/8 inch	10 feet
8 to 12 inches	7/8 inch	12 feet
PVC & ABS (all sizes)	3/8 inch	4 feet
Cast Iron No-Hub	5/8 inch	5 feet and at joints
7. Provide hangers within 12 inches of each horizontal elbow.
8. Provide hangers with minimum 1-1/2 inches vertical adjustment.

2.3 INSULATION:

A. General:

1. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
2. Fire-Test-Response Characteristics: Insulation and related materials NFPA 255, UL Classified per UL 723 or meeting ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement containers, with appropriate markings of applicable testing and inspecting agency.
 - a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

- b. Insulation Installed Outdoors: Flame=spread index of 75 or less, and smoke-developed index of 150 or less.

B. Piping:

1. All domestic, potable & non-potable, hot and cold water lines and rain drains shall be insulated with preformed insulation.
 - a. Fiberglass insulation with a vapor barrier jacket. Insulation shall have a conductivity not exceeding 0.28 Btu-inch/hour-sq. ft.-degrees F. Laps and butt joints shall be sealed with pressure sensitive joint sealing tape of the same finish as the insulation jacket to provide a continuous vapor seal. Fittings and valves shall be insulated with PVC fitting covers and fiberglass insulation inserts, or with hydraulic setting insulating cement and four ounce canvass jacket with vapor barrier adhesive.

Insulation thicknesses shall be as follows:

<u>System</u>	<u>Pipe Sizes</u> <u>1/2" and above</u>
Domestic Cold Water (pot. & non-pot.)	1/2"
Domestic Hot Water & Recirc. (pot. & non-pot.)	1"
Roof Drain Piping	1/2"
Overflow Drain Piping	1/2"

2. Roof and overflow drain sumps shall be insulated with 1/2" thick fiberglass with a vapor barrier, extending 2" onto adjacent insulation.
3. Insulation shall be installed in strict accordance with manufacturer's instructions.
4. Insulation shall be continuous through penetrations.
5. All insulation shall be installed in a neat and workmanlike manner.

2.4 VALVES & STRAINERS:

A. Ball Valves:

1. Valves 2-inches and smaller shall be cast brass body, chrome-plated brass ball, teflon seats, and lever handle, 600 psi CWP. Valves shall comply with MSS SP-110. Valves over 2-inches shall be cast steel body, chrome plated steel ball, teflon seats, and lever handle. Victaulic, Anvil Gruvlok, Grinnell, or Shurjoint ball valves are acceptable if grooved piping is used. Valves mounted higher than 7'-0" A.F.F. shall be provided with chain, wheel, and guides.

B. Butterfly Valve:

1. Valves 12-inches and smaller shall be ductile iron lug body, ASTM A-536, 316 stainless steel disc, EPDM Liner, 316 stainless steel stem, and safety twist-lock multi-position lever handle with open-closed lockout capabilities. Valve shall be rated at 175 psig WOG. Valves mounted higher than 7'-0" A.F.F. shall be provided with chain wheel and guides. Valves shall comply with MSS SP-67. Victaulic, Anvil Gruvlok, Grinnell, or Shurjoint

butterfly valves are acceptable if grooved piping is used.

C. Check Valves:

1. Valves 2-inches and smaller shall be bronze body Y-pattern, ASTM B-62, swing check, bronze disc, 200 psi WOG. Valves shall comply with MSS SP-80. Valves, over 2-inches shall be iron body, ASTM A-126, bronze trim, swing check, renewable disc and seat. Valves shall comply with MSS SP-71. Victaulic, Anvil Gruvlok, Grinnell, or Shurlock check valves are acceptable if grooved piping is used.
2. Swing check valves with outside lever and spring (not center guided) is to be used on sewage ejector or storm-water sump pumps.

D. Pressure Reducing Valves:

1. Valves 2-inches and smaller shall be bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, and single union end.

E. Balance Valve:

1. Valve shall have a twin tube 316 S.S. design with blowout proof attachment to station body. Ports shall include 3/4" port for thermometer, 1/4" port for pressure gauge, air vent, and 1/2" drain port.
2. The instrument station shall be 120/150-flanged construction.
3. The butterfly valve shall be lug pattern with a rating of 200 WP, 250 deg. F. The valve shall have an infinite. Position operator with memory stop (6" and smaller), worm gear with memory stop (8" and larger).

F. Strainers:

1. Strainers shall be cast steel body, Y-pattern, 20-mesh stainless screen. Victaulic, Anvil Gruvlok, Grinnell, or Shurjoint strainers are acceptable if grooved piping is used.

PART 3 - EXECUTION

3.1 WORKMANSHIP:

A. General:

1. Install all piping, fixtures, equipment, and accessories as shown, and in strict accordance with the plumbing laws, rules, and regulations of the State and/or City. All work shall be done in a neat and orderly fashion, and left in a condition satisfactory to the Architect/Engineer.

B. Piping:

1. All piping shall be run parallel or perpendicular to established building lines. Install piping so as to allow for expansion. Waste and vent piping occurring above floor slab shall be

installed true and plumb. Extend vents at least 1 foot above roof, or to the top of the closest adjacent parapet wall, whichever is greater, and provide watertight flashing sleeves. Excavation and backfill shall be in accordance with Section 220000 of these specifications.

C. Fixtures:

1. Install fixtures true and plumb with building walls. Caulk all plumbing fixtures at joints along walls, countertops, and other intersecting surfaces. Locate fixtures as shown and per manufacturer's instructions. Furnish all required trim for fixtures to provide a complete and workable installation.

3.2 TESTS:

A. General:

1. All piping, fixtures, and equipment shall be inspected and approved before concealing or covering. All work shall be tested as required by Section 220000 of these specifications, and shall be leak proof before inspection is requested. All tests shall be repeated if required by those making the inspection.
2. All potable water systems shall be flushed and disinfected in accordance with Section 220000 of these specifications. Following disinfection, system shall be flushed and water sampled to show compliance with requirements of public health authority having jurisdiction. If tested water does not meet requirements, disinfecting shall be repeated until water quality meets requirements.
3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gasket shall be molded and produced by Victaulic Company, Gruvlok, or Grinnell Mechanical Products, or equal. Verify gasket grade is suitable for the intended service. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel the use of grooving tools, application of groove, and installation of grooved end products.
 - a. All grooved joint couplings, fittings, valves and specialties shall be the products of Victaulic Company, Gruvlok, Grinnell Mechanical Products, or equal.
4. Install the grooved piping in accordance with the latest recommendations as published by the manufacturer. Pipe shall be square cut, $\pm 0.30''$, properly deburred and cleaned. Mark pipe ends at the required location using a gauge supplied by the manufacturer to ensure full insertion into the coupling or fitting during assembly. Use a manufacturer's tool with the proper sized jaw for pressing.

B. Fixtures and Equipment:

1. Fill all plumbing fixtures with water and check for leaks or retarded flow. Repair as required. Adjust each piece of plumbing equipment as required to insure proper functioning. Leave all fixtures and equipment in first class operating condition.
2. The Plumbing Contractor is responsible for all backflow devices to be inspected by a certified backflow technician before use of the building potable water system.

C. Smoke Test:

1. A smoke test shall be performed on the entire waste and vent system before building occupancy. After all fixtures are permanently connected and traps are filled with water, fill entire drainage systems with smoke under pressure of 1.3 pKa (1 inch of water) with a smoke machine. If leaks are detected, they shall be repaired and the smoke test shall be performed again until no leaks are found.

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PIPING SYSTEM TEST REPORT

STRUCTURE/BUILDING: Boise Fire Station

TEST NUMBER: _____

LOCATION: Boise, Idaho

CONTRACT NO. _____

DESCRIPTION OF SYSTEM/PIPING BEING TESTED: _____

Description of Test Performed	Test Pressure	Test Duration	Pass/Fail
Hydrostatic: _____	P.S.I. _____	_____	_____
Inert Gas: _____	P.S.I. _____	_____	_____
Compressed Air: _____	P.S.I. _____	_____	_____
Waste & Vent Smoke Test: _____	1" Water Column _____	_____	_____

NAME AND TITLE OF PERSON IN CHARGE OF PERFORMING TEST'S FOR CONTRACTOR:

Name: _____ Title: _____

Signature: _____

I hereby certify that the above described system has been tested as indicated above and found to be entirely satisfactory as required in the contract specifications.

Signature of Inspector: _____ Date: _____

REMARKS: _____

END OF SECTION 220100

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

SECTION 230000 - HVAC GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. The Bidding Requirements, Contract Requirements, and the General Requirements (Division 1) of these specifications shall govern all parts of the work.

B. Work Included:

1. Install work in accordance with these specifications and the accompanying plans. Furnish all labor, material, and equipment together with all incidental items not specifically shown or specified which are required by good practice to provide the complete mechanical systems as described.
2. The HVAC Contractor(s) and all Sub-tier Contractors shall provide installed equipment cut sheets and purchase orders required for utility rebates.

C. Coordination and Site Visits:

1. This section of the work requires examination of and reference to all architectural, structural, utility, and electrical drawings for construction conditions that may affect the work. Inspect the building site and existing facilities for verification of existing conditions. Base all measurements from established benchmarks. Any discrepancy between actual measurements and those indicated, which prevents following good practices or the intent of the drawings and specifications, shall be reported to the Architect/Engineer, and work halted until instructions are received from the Architect/Engineer.

1.2 CODES, PERMITS, FEES:

- A. Install all work in accordance with applicable codes and standards. Obtain all required permits; pay all required fees including utility connections or extensions, in connection with this portion of the construction. Obtain all required certificates of inspection for the work.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP:

A. Materials:

1. All materials and equipment shall be of first quality, new, full size and weight, standard in

every respect, and suitable for the space required. Use the same manufacturer for products of similar class or service, such as valves, pumps, controls, and air handlers. Protect all materials against loss, theft, or damage before and after installation.

2. Furnish equipment that will operate under all conditions of load without any sound or vibration that is objectionable in the opinion of the Architect/Engineer. Vibration or noise considered objectionable will be corrected by the Subcontractor at his expense.
3. Furnish and install all necessary foundations, supports, pads, bases, and piers required for all materials and equipment furnished under this contract.
4. Provide all required firestopping at duct penetrations of fire rated walls, floors, ceilings, and roofs. Firestopping shall be Dow Corning Fire Stop Sealant 2000 or Fire Stop Foam 2001, or approved equal.

B. Workmanship:

1. All materials and equipment shall be installed in a neat and workmanlike manner by competent specialists for each subtrade. Work shall be installed to the satisfaction of the Architect/Engineer with unsatisfactory work removed and reinstalled to his satisfaction at no extra cost to the Owner.
2. Provide all cutting and patching necessary to install the work specified in this section. Patching shall match adjacent surfaces. No structural members shall be cut without the approval of the Architect/Engineer. Provide sleeves at all piping penetrations of exterior walls and floors on grade. Provide all sleeves and inserts required before new floors and walls are built.
3. Locate all equipment that must be serviced in fully accessible positions. Provide clearance for removal of replacement parts and components, and with necessary couplings or flanges to remove the component for maintenance.

C. Protection of Equipment During Construction:

1. At the end of each shift, all duct openings and open ends shall be covered with a plastic poly sheeting film to protect against dust and construction contamination from entering the ductwork.

2.2 SUBMITTALS AND SUBSTITUTIONS:

A. Prebid Approval:

1. Manufacturer's trade names and catalog numbers stated herein are intended to indicate the quality of equipment or materials desired. All manufacturers not specifically listed require prior approval. Submit catalog data, including specifications, of the proposed equipment to the Architect/Engineer for his approval at least 10 calendar days prior to bid opening. Notice of such approvals will be published in an addendum. Approval of listed alternate equipment manufacturers is for bidding only. Final approval is to be based on requirements of the plans and specifications.

B. Submittals:

1. Within thirty days after award of this contract, provide six copies of a complete list of all materials and equipment proposed for this project. List shall contain make, type, manufacturer's name, and trade designation of all materials and equipment. Submittal shall also include manufacturer's complete specification for each item, including capacities, ratings, etc., and dimensions as required to check space requirements. Provide six copies of all submittals. The scheduled equipment is the basis of design for capacity, weights, physical size, etc. Alternate manufacturers shall not exceed the weight or physical size. Any changes to the Architectural, Structural, Mechanical, Electrical, and Control systems due to alternate manufactures shall be the responsibility of the Contractor and Supplier. Submittals for each major trade (i.e., dryside HVAC, wet-side HVAC, or Plumbing) shall be submitted in a single complete package. Individual items will not be reviewed independently unless approved by the Engineer. Electronic submittals will be allowed when approved by the Architect and, or Owner. The requirements of electronic submittals are the same as those noted above.
2. Approval of submittals shall not relieve the contractor from responsibility for deviations from the plans or specifications, unless he has, in writing, called the Architect's /Engineer's attention to deviations at the time of submission, and obtained his written approval. Approval of submittals does not relieve the contractor from responsibility for errors in shop drawings or literature.

C. Equipment Requiring Submittals:

1. Variable Refrigerant Volume (VRF) Systems
2. Heat Recovery Ventilator
3. Exhaust Fans
4. Electric Heaters
5. Radiant Tube Duct Heaters
6. Evaporative Coolers
7. Penthouse Ventilators
8. Motorized Dampers
9. Circulation Fans
10. Grilles / Diffusers
11. Pipe Stands
12. Flex Duct
13. Direct Digital Controls

PART 3 - EXECUTION

3.1 ACCESSIBILITY & SAFETY:

A. Accessibility:

1. All equipment which must be serviced or operated shall be located in fully accessible position. Minor changes from the drawings may be made to allow for better accessibility. All changes shall be approved prior to actual installation.
2. Access panels shall be provided if required for accessibility. Access panels to be steel, flanged, hinged doors by Cendrex, or equal. Sized as required for installation. Subcontractor shall furnish the required panels to the General Contractor and the required location for all access panels, unless otherwise specified in the Architectural specifications. Panels shall be installed by the General Contractor.

B. Safety:

1. Subcontractor shall provide guards for all belt drives and rotating machinery.

3.2 COORDINATION:

- A. Coordinate all work with the various trades involved to provide a complete and satisfactory installation. The exact details of ductwork and equipment are not shown. No additional compensation will be made for offsets or relocation required in coordination with other trades.
- B. Alterations required due to improper supervision by the subcontractor shall be made at no extra cost, to the satisfaction of the Architect/Engineer.

3.3 ELECTRICAL:

- A. Electric motors required for equipment specified in this section shall be provided and installed by this Subcontractor. Motor starters, disconnects, relays, pilot lights, etc., are in general, to be furnished and installed by the Electrical Contractor. Starters, relays, controls, etc., which are factory assembled into packaged equipment shall be furnished by the Mechanical Contractor under this section of the specifications.
- B. All motors shall be provided with adequate starting and protective equipment as specified or required. Motor capacity shall be sufficient to operate driven device under all conditions of operation and load without overload. Minimum horsepower shall be as specified.

3.4 IDENTIFICATION AND CODING:

A. Painting:

1. All painting of mechanical equipment, accessories and ductwork shall be furnished and applied under the Architectural section of these specifications. All painting shall be completed before any identification markings are applied.

B. Equipment:

1. Identify all equipment with a black Formica label, with white reveal when engraved. Lettering to be 3/16 inch high minimum. In general, identify equipment as to area served in addition to title and code number of the equipment as taken from the plans.

C. Piping:

1. Identify all piping as to the service of the pipe and the direction of flow. The letters shall be 3/4 inch high on piping two inches or smaller, and 1-1/4 inches high on piping up to six inches. Flow arrows shall be at least six inches long. The letters and flow arrows shall be made by precut stencils and oil base paint, one inch high and black, or factory fabricated plastic pipe markers. Piping shall be identified at 25 foot maximum intervals, on long continuous lines; adjacent to each item of equipment; on each riser and junction, and on both sides of all wall penetrations. Underground piping shall be identified with bright colored continuously printed plastic tape of not less than 6" wide by 4 mil thick, manufactured for direct burial service. Install directly above all buried pipe, 6 to 8 inches below finished grade.

3.5 TESTING:

A. Systems:

1. All systems, including heating, ventilating and air conditioning, shall be tested at the completion of the building to establish that the systems operate as specified and required. Testing shall be performed after air balancing is completed.
2. All controls shall be calibrated accurately and all equipment shall be adjusted for satisfactory operation. Excessive vibration or noise from any system shall be corrected.
3. The air conditioning system shall be tested for satisfactory operation when the outside air temperature reaches 60 degrees F. or warmer. All other systems shall be tested at building completion. All tests shall be performed in the presence of the Architect/Engineer or his representative.

3.6 BALANCING:

A. Scope:

1. Prior to final acceptance by the Owners, all air systems shall be balanced to deliver the quantities as specified or directed. The air balance shall be performed by an independent agency specializing in balancing and is certified by the National Environmental Balancing Bureau.
2. Balance contractor's main office shall be located within 50 miles from the project site. Approved balance contractors are Felts-House Engineering, Ro-Bar Technical Services, and Building Systems Technologies. All other contractors must receive prior approval from the Engineer, in writing, before bidding the project.
3. The Mechanical Contractor shall provide assistance to the Balancing Contractor by identifying all installed mechanical systems and assisting access to all installed mechanical systems. All mechanical systems shall be completely operational and functional prior to

the Balancing Contractor performing their specified work.

B. Air balancing:

1. Balancing of the air system shall consist of:
 - a. Adjust all air volumes to the quantities shown, with allowable variation of plus 10, minus 10 percent.
 - b. Record all system, zone, diffuser, grille, and register C.F.M. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Balancing Engineer shall work with the Contractor to set minimum & maximum CFM quantities for zone dampers, or zone dampers/heaters.
 - c. Test and record all system static pressures, inlet and discharge, on all packaged units, fans, and terminal units. Vary total system air quantities by adjustment of fan speeds. Provide drive changes as necessary. Vary branch air quantities by damper regulation.
 - d. Test and record motor full load amps and nameplate amps.
 - e. Test and record entering and leaving temperatures at all coils.
 - f. Adjust all automatically operated dampers, in cooperation with the Control Contractor, to the required settings. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions within specified tolerances. Where modulating dampers or economizers are provided, take measurements at full return air, minimum outside air, and 100 percent outside air mode of operation.
 - g. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and excessive noise where possible.
 - h. Mark final positions of all balance dampers with a red felt pen.
 - i. Air systems shall be balanced in accordance with standard procedures and recognized practices of the Associated Air Balance Council, and the Testing Adjusting, and Balancing Bureau.

C. Quality Assurance:

1. The Balancing Contractor shall demonstrate to the Engineer of record, flow verification for at least 10% of the balanced devices as selected by the Engineer. If more than 25% of the tested devices do not meet the designed or balance report, then the entire system balance must be rebalanced.

D. Balance Reports:

1. Submit four copies of the air system balance report to the Architect/Engineer for evaluation and approval. Reports shall be on TABB/SMACNA forms that indicate information addressing each of the testing methods, readings, and adjustments.

3.7 CLEANING AND ADJUSTING:

- A. Thoroughly clean all air conditioning units, air handling units, and all associated parts of the system at the completion of the work. Install new, clean air filters in all systems. Adjust all devices for proper operation and lubricate all equipment as required. Repaint any painted surface that has been damaged.

3.8 PROJECT CLOSEOUT:

A. Operations & Maintenance Manual:

The Contractor shall provide an operations and maintenance manual at least thirty days prior to completion of work. The manual shall be of the three ring binder type, entitled "Operations and Maintenance Manual", with the job name and year of completion also included. O & M manuals shall be submitted in a single package. Individual items will not be accepted independently unless approved by the Engineer. The manual shall include, as a minimum:

1. Maintenance instructions for all equipment, including lubrication requirements.
2. Equipment suppliers names, addresses, and telephone numbers.
3. Equipment catalog cuts, ratings tables, model numbers, serial numbers, and accessories.
4. Parts numbers for all replaceable parts.
5. Air systems balance report as hereinbefore specified.
6. Control diagram or drawing and operation sequence.
7. Valve tagging chart as hereinbefore specified.
8. Filter chart listing unit callout, size of filters, and quantity of filters.
9. Guarantee letter as specified below.
10. Any additional information required to enable the Owner to properly maintain the building mechanical system.
11. Mechanical Equipment Start-up forms, which are included in this specification, if they are required.
12. After approval of the Operations and Maintenance Manual by the Architect/Engineer, the Contractor shall furnish two copies of the manual to the Owner.

B. Mechanical System Training Period:

1. After the mechanical system is completely installed and operational, the mechanical contractor shall provide a minimum of 4 hours training and instruction time for the building Owner or his representative. During this period, the contractor shall instruct the Owner in the operation and maintenance of all parts of the mechanical system, using the O & M manual where applicable. The contractor shall provide a copy of the Project Owner Mechanical Systems Training Form (attached to this specification), with proper signatures, to the Engineer prior to substantial completion and insure that a copy is inserted into the project O & M manuals.
2. Video Taping – The mechanical contractor is to perform videotaping of the Owner training and instruction. Provide two (2) CD copies to Owner and one (1) copy to be inserted into the O & M Manuals.

C. As-Built-Drawings:

1. Provide two sets of blue-line mechanical drawings showing the work as it was actually

installed. The drawings shall indicate all departures from the contract drawings. Make all notations neat and legible, with red indelible pencil. At the completion of the work, these as-built drawings shall be signed and dated by the Mechanical Contractor, and returned to the Architect/Engineer.

D. Guarantee:

1. All work furnished under this section shall be guaranteed in writing to be free from defective work or materials for a period of one year after acceptance of the contract. All repairs or replacements because of defective materials or workmanship or noncompliance with code shall be provided without additional cost to the Owner. Contractor shall furnish a letter indicating above guarantee with space for date of acceptance and expiration of guarantee. Letter shall be included in O & M Manual.

END OF SECTION 230000

NAME OF PROJECT: Boise Fire Station

Boise Idaho

OWNER MECHANICAL SYSTEM TRAINING FORM

Upon completion of the equipment and systems installation and connections, the contractor shall assemble all required equipment factory representative and subcontractors together for system Owner training.

These people shall assist in Owner training their system(s) and remain at the site until the total system operations is acceptable and understood by the Owner's representative(s), maintenance and/or operation personnel, on operation and maintenance of their equipment. To prove acceptance of operation and instruction by the Owner's representative(s), the contractor shall provide a copy of this form, with proper signatures, to the Engineer prior to substantial completion, and insure that a copy is inserted into the project Operation and Maintenance manuals.

"I, the Contractor, associated factory representative and subcontractors, have started each system and the total system(s); and have proven their normal operation to the Owner's representative(s) and maintenance/operation personnel and have instructed him/them 4, hours in the operation and maintenance thereof."

Owner's Representative

Contractor

Signature

Signature

Date

Date

SECTION 230100 - HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the work necessary for the heating, ventilating, and air conditioning system, complete. The HVAC General Requirements, Section 230000, is to be included as a part of this section of the specifications.

1.2 CODES & STANDARDS

- A. The heating, ventilating, and air conditioning system shall be installed in accordance with the latest edition of the following codes and standards:
 - 1. International Mechanical Code (IMC)
 - 2. International Building Code (IBC)
 - 3. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
 - 4. National Fire Protection Association (NFPA)
 - 5. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS AND APPURTENANCES

- A. Energy Recovery Ventilator (wheel type)
 - 1. Description:
 - a. Unit shall be a belt driven energy recovery ventilator.
 - b. Packaged heat recovery ventilator with a factory installed energy recovery wheel.
 - 2. Certifications:
 - a. Unit shall be listed by Underwriters Laboratories (UL 1812) and UL listed for Canada (cUL 1812). Unit shall be ARI certified. Unit shall bear the AMCA certified ratings seal for air performance.
 - b. Insulation shall comply with NFPA 90A requirements for flame spread and smoke generation.
 - 3. Construction:
 - a. The unit shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18 gauge galvanized steel, bolted to a minimum 16

gauge galvanized steel base with integral lifting lugs. Unit shall be provided with insulated top, side and interior panels utilizing 1" thick, three pound density foil faced insulation, manufactured and tested to meet NFPA 90A and UL 181 requirements. Insulation shall be fastened to the panels with weatherproof adhesive and weld pins. Energy recovery wheel shall be mounted in a slide track for easy inspection and cleaning. Separate blower and motor shall be provided for supply and exhaust airstream for independent system balancing. Blower and motor assemblies shall be mounted on rubber vibration isolators. Two inch thick, MERV 8 efficient pleated filters shall be provided for supply and exhaust airstreams. Hinged access panels shall be provided for easy access to motors, blowers, filters and energy recovery wheel. Unit shall bear an engraved aluminum nameplate.

4. Energy Wheel:
 - a. Wheel shall be a total energy recovery wheel constructed of fluted synthetic fiber-based media impregnated with a non-migrating water selective 4 angstrom molecular sieve desiccant. Wheels with the desiccant applied in a secondary operation will not be accepted. Energy transfer ratings shall be ARI certified, based on ARI Standard 1060-2000.
5. Fan Wheel:
 - a. Wheel shall be DWDI centrifugal forward curved type, constructed of painted steel. Wheel shall be balanced in accordance with AMCA Standard 204-96.
6. Motor:
 - a. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.
7. Controls and Electrical:
 - a. All internal electrical components shall be pre-wired for single point power connection. Internal control panel shall be UL listed with hinged access door and interlocking NEMA 3R disconnect switch. Each motor shall have a motor starter combination providing fuseless disconnect, over-current, overload and motor starting functions. A 24 volt circuit shall be provided to allow remote on/off control of ERV by building control system. Short circuit protection shall be provided on primary and secondary of control power transformer.
8. Bearings:
 - a. Bearings shall be permanently lubricated, sealed ball bearing pillow block type, selected for a minimum L10 life in excess of 100,000 hours at maximum cataloged operating speed.
9. Belts and Drives:
 - a. Belts shall be oil and heat resistant, non-static type. Drives shall be precision, machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.
10. Angular Filters:
 - a. The filter section shall include filter racks, and hinged and latching access doors on either, or both sides of the section for side loading and removal of filters. Angular

filter arrangements are provided with 2 inch deep, MERV 8 pleated panel filters. Filters media is U.L. Class 2, and tested according to U.L. Standard 900.

- b. Provide (4) extra sets of 2" pleated, MERV 8 filters per unit.
- 11. Defrost:
 - a. See equipment schedule on plans for specific requirements.
 - 12. Manufacturer, Capacity & Accessories:
 - a. See equipment schedule on plans for specific requirements.
- B. Evaporative Cooling System:
- 1. Direct Evaporative Cooler:

Direct evaporative cooling system shall include the housing, flanges, access doors, water sump, water distribution system, pump(s), overflow, drain, and clean outs, bleed-off system, and evaporative cooling media. Service access to all components such as pump(s), plumbing, distribution header, balancing, unions, balancing valves, fill valves, bleed meters, electrical boxes, etc. shall be provided. The evaporative cooling media shall be CELdek® cellulose evaporative cooling media [GLASdek® fiberglass], [6 inches, 12 inches, 18 inches] deep. It shall be as specified below as EVAPORATIVE MEDIA.
 - 2. Casing/Flanges:

Casing and flanges to be constructed of die formed, 14 gauge 304L stainless steel. All outer panels shall be bolted together on the exterior using stainless steel bolts. The leaving air side of the unit shall have a removable channel section for access to and for removal of the water distribution header. Channel shall be constructed of die formed, 14 gauge 304L stainless steel. Units with media over 72 inches in height will be shipped in individual sections for field assembly by the installing contractor.
 - 3. Media Retainers:

Provide each row of media, top and bottom, with angle metal retainers. The edges of the upper retainers not welded to the casing shall have the edges turned inwards towards the media. Retainers shall prevent the air velocity of the system from pushing the media out of the frame. Media retainers shall overlap media by 1 inch minimum with all upper bends returning into the media and lower bends turned out. Retainers to be constructed of 14 gauge, 304L stainless steel.
 - 4. Media Intermediate Supports:

For systems with media banks that are stacked two high, a media retainer located between the upper and lower media banks, shall independently support the upper media bank. The top media support shall allow even water flow from the upper media to the lower media. Provide an expanded metal support plate with 50% open area. Plate is to be removable from the unit to provide access to service the media. Provide a one inch "T" located between the upper and lower media, on the front and back of the media. Intermediate support shall be 2 inch wide. Plate, "T", and intermediate support to be constructed of 14 gauge, 304L stainless steel.

Intermediate support shall reduce the risk of media bowing as a result of air velocity through the media. The intermediate support shall keep the media from tipping out of the

frame. Intermediate support for pads taller than 60 inches shall be located between $\frac{1}{2}$ and $\frac{2}{3}$ of the overall height from the bottom of the media.

5. Baffle:
Provide a full width baffle from the bottom of the lower media support to a point 2 inches below the lowest sump water level. Baffle to be designed to prevent air from short circuiting under each bank of media. Baffle to be constructed of 14 gauge, 304L stainless steel.
6. Water Sump:
Water sump shall be constructed of die formed, 14 gauge 304L stainless steel. All components of the sump shall be continuously TIG welded. Sump to be factory leak tested. Provide sump with drain and overflow couplings constructed of stainless steel. Couplings to be half coupling, threaded NPT fittings that are continuously welded to the sump. Drain fitting to be tapered and notched so that when installed it is located below the lowest point of the sump. Sump bottom to be cross broken and sloped to assure positive draining of entire sump pan. Drain and overflow lines to be 2 inch minimum.
7. Plumbing & Piping:
Pump and distribution systems shall be sized for 1.2 times maximum design water flow rate. After valves, fittings, flow meters, etc. the water pressure to the water distribution header at 1.2 times the water flow rate shall be 2 psig.
8. Float, Fill & Valves:
The fill line is to be controlled by a heavy duty bronze float valve with full valve seat. All piping, unions and valves shall be schedule 80 PVC. Valves for the water distribution header, drain, and clean-outs to be manual ball type. Provide pipe unions for service and removal of pump(s), valves, distribution header and splash cover.
9. Water Distribution Header:
The distribution header shall consist of a length of PVC pipe directly on top of the media or suspended immediately above it. The header shall have holes drilled along the top, spaced at equal intervals. The holes shall be directed upwards and slightly towards the air-entering face of the media. The distribution header should be designed for a wide range of flow rates to insure good distribution to the media, should the actual water flow vary from the design point. Each end of the distribution header to have manual ball valves to facilitate periodic cleaning and flushing of the header pipe. Valves to be piped downward to the water sump to facilitate cleaning of the distribution header. Unit to be designed so that flushing of the distribution header may be performed during operation.
10. Splash Cover:
Provide a splash cover to disperse the water from the distribution pipe jets into an even film to the distribution media. Splash cover shall prevent droplets from escaping around the top housing. Splash cover shall rest on or nearly touch the distribution media. The air entering edge of the splash cover should be placed slightly back from the air-entering side of the media. The splash cover shall also cover 50% minimum of the top of the distribution pad. Splash cover to be fabricated from a $\frac{1}{2}$ length wise piece of Schedule 40, PVC pipe.
11. Flow Balancing Valve(s):

Provide a flow balancing valve for each media bank to insure correct water flow. Valve to be able to provide the correct water flow over a wide range of water pressure. Balancing valve(s) shall be factory set and marked.

12. Bleed-Off System:

Bleed-off system shall insure that the evaporation process shall not allow high concentrations of minerals and other impurities to concentrate in the water. Bleed line shall be piped into sump overflow line. Bleed-Off System shall consist of a Conductivity Controller described below.

13. Conductivity Controller:

The bleed-off system shall include a conductivity controller which indicates the conductivity of the sump water. The controller shall utilize electronic measurement systems with solid state components. The controller shall continuously monitor total dissolved solids (TDS) by measuring electrical conductivity in micromho's per centimeter in the water sump. The controller shall include a conductivity measuring sensor which opens a solenoid valve to bleed the sump when the water conductivity reaches a preset level. The sensor shall be a temperature compensated, flow through electrode type. Electrode to be supplied with 3/8" tubing fittings. The controller shall include a heavy-duty, prewired steel enclosure, NEMA type 1 rated for industrial environments.

14. Pump(s):

Pump(s) shall be centrifugal, submersible-type, thermally protected. Pump to be located in the bottom of the water sump. Pump(s) shall include cleanable stainless steel suction screen. Pump motor to be enclosed in hermetically sealed, cast housing filled with dielectric oil. Motor wiring to be in a neoprene jacket cord that is terminated in a water tight junction box. Power connections, disconnect switches, fuses, terminal blocks, motor starter, etc. to be provided by others. Motor to be UL or ETL approved. Voltage, phase and amp draw as indicated on the schedule.

15. Distribution Pad:

A water distribution pad with a thickness of 2 inches shall be provided and installed across the top cross section of the media to provide for the even distribution of water. Two distribution pads shall be provide for media depths greater than 12 inches. The distribution pad shall be CELdek® or GLASdek® media and constructed of the same material as that of the cooling media. The distribution pad shall have a synthetic edge coating applied to each face, to prevent erosion, enhance strength and provide for cleaning. This edge shall effectively break up the water from the splash cover to further assure an even water flow across the top of the media bank.

16. Evaporative Media:

Media shall be GLASdek® evaporative cooling/humidification fiberglass as manufactured by Munters Corporation. GLASdek® media shall be fire rated with UL 900, Class II for depths up to 12 inches. The engineered media shall be self-supporting, impregnated, and treated to give high absorbency and protection against decomposition through the effects of water and air. It shall consist of unique design characteristics to assure even air flow and higher evaporative cooling efficiency while preventing clogging and biological degradation. It shall be a cross-fluted, self-cleaning design. Saturation efficiency for a 12 inch depth in the direction of the air flow, will not be less than 90%

when operated at up to 400 feet per minute (fpm) face velocity. The media air passage flutes shall form an angle of 15 degrees with the horizontal air flow and the water passage flutes shall form an angle of 45 degrees with the horizontal air flow.

Media manufactured from aspen wood, horse hair, glass wool or any other random or synthetic materials shall not be allowed.

17. Testing & Certification:

Media cooling effectiveness and resistance to air flow shall be certified by the manufacturer that it is tested according to ASHRAE 41.2 – 1987 Standard Methods for Laboratory Air Flow Measurement, Figure 15.

18. Start Up:

Prior to startup of the evaporative cooling equipment, the installing contractor shall assure that all equipment is properly installed and connected according to the manufacturers written installation instructions and drawings. All equipment shall be installed tightly and squarely with all adjoining sections of the air handler inlet housing. Prior to starting the unit, the sump shall be thoroughly cleaned and flushed-out of any dirt or debris. Activate the water distribution manual flow valves on the media banks. Start the water pump(s). Assure that all valves are open and that water is flowing to each bank. Assure that the proper flow rate is being delivered to the media. Run water over the media for a period of one hour to thoroughly flush-out the media. Clean out the sump with a water hose. Drain the media pads for 15 minutes. Stop the pump(s) and start up the fans and run air for one hour without running water on media. The unit can now be started.

19. Warranty:

The manufacturer shall warrant that the supplied system (parts only) shall be free from defects in materials and workmanship for a period of 1 (one) year commencing from the date of shipment. This warranty is provided that the system and media is installed and maintained according to the manufacturer's written instructions and details contained in their Engineering Bulletins.

20. Quality Assurance:

The manufacturer of the evaporative cooling system(s) and media shall be certified to the quality standard system ISO 9001, 1994.

2.2 HEAT GENERATION

A. Infra-Red Heaters:

1. General:

- a. Heaters shall be straight tube gas fired radiant type, and shall be AGA certified. Heaters shall operate satisfactorily in any position from horizontal to 45 degrees from horizontal. Heaters shall be furnished as a packaged unit, including all required hangers, air intake collars, vent collars, controls, and accessories for a complete installation.

2. Construction:

- a. Combustion chamber shall be 16 gauge titanium alloy aluminized steel, 4" O.D. , coated with high temperature corrosion resistant black paint with an emissivity rating of .95. Radiant tube emitter shall be 16 gauge aluminized steel with same coating. Reflectors shall be .025 bright aluminum designed to provide uniform irradiance levels, and shall be adjustable.
 3. Heater and Controls:
 - a. Heater shall be equipped with a direct silicon carbide glo-bar ignition control system, operating with 120 volt power. Controls shall include automatic shutdown upon gas interruption, redundant dual solenoid valves, two pressure differential switches, and pre-purge controls. Units shall be controlled by wall mounted thermostats.
 4. Capacity:
 - a. See drawings for capacity and accessories.
- B. Ductless Split System - Wall-Mounted Units
1. General:
 - a. Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling/heating coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall mounting bracket and mounting hardware. Unit shall be rated per ARI Standards 210/240 and UL labeled.
 2. Unit Cabinet:
 - a. Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.
 3. Fans:
 - a. Fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
 - b. Air sweep operation shall be user selectable. The vertical sweep may be adjusted (using the remote control) and the horizontal air direction may be set manually.
 4. Coil:
 - a. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap.
 5. Motors:
 - a. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.
 6. Controls:
 - a. Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature control range shall be from 62° F to 84° F.

- b. The unit shall have the following functions as a minimum:
 - 1) An automatic restart after power failure at the same operating conditions as at failure.
 - 2) A timer function, to provide a minimum 24-hour timer cycle for system Auto Start/Stop.
 - 3) Temperature-sensing controls shall sense return air temperature.
 - 4) Indoor coil freeze protection.
 - 5) Wireless infrared remote control to enter set points and operating conditions.
 - 6) Automatic air sweep control to provide on or off activation of air sweep louvers.
 - 7) Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.
 - 8) Fan-only operation to provide room air circulation when no cooling is required.
 - 9) Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.
 - 10) Fan speed control shall be user-selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.
 - 11) Automatic heating-to-cooling changeover in heat pump mode. Control shall include deadband to prevent rapid mode cycling between heating and cooling.
 - 12) Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature when unit is in heat pump mode.
- 7. Filters:
 - a. Unit shall have filter track with factory-supplied cleanable filters.
- 8. Electrical Requirements:
 - a. Power is supplied from outdoor unit.
- 9. Special Features (Field Installed, if necessary):
 - a. Condensate Pump: The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts; an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. A liquid level sensor in the reservoir shall stop cooling operation if the liquid level in the reservoir is unacceptable.
- 10. Warranty:
 - a. Minimum 1 year parts limited warranty.
- 11. Outdoor Units:
 - a. General:
 - 1) Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the compressor.
 - 2) Units shall consist of a rotary compressor, an air-cooled coil, propeller-type draw-through outdoor fan, reversing valve (HP), accumulator (HP units), metering device(s), and control box. Units shall discharge air horizontally as shown on the contract drawings. Units shall function as the outdoor component of an air-to-air cooling only, or heat pump system.

- 3) Units shall be used in a refrigeration circuit matched to duct-free cooling only or heat pump fan coil units.
- b. Unit Cabinet:
 - 1) Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish on inside and outside.
 - 2) Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
 - 3) Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.
- c. Fans:
 - 1) Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall draw air through the outdoor coil.
 - 2) Outdoor fan motors shall be totally-enclosed, single phase motors with class B insulation and permanently-lubricated ball bearings. Motor shall be protected by internal thermal overload protection.
 - 3) Shaft shall have inherent corrosion resistance.
 - 4) Fan blades shall be non-metallic and shall be statically and dynamically balanced.
 - 5) Outdoor fan openings shall be equipped with PVC metal/mesh coated protection grille over fan.
- d. Compressor:
 - 1) Compressor shall be fully hermetic rotary type.
 - 2) Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from over-temperature and over-current.
 - 3) Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere.
 - 4) Compressor assembly shall be installed on rubber vibration isolators.
- e. Outdoor Coil:
 - 1) Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.
- f. Refrigeration Components:
 - 1) Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, reversing valve. Provide tamper proof port caps.
- g. Controls and Safeties:
 - 1) Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:
 - a) A time delay control sequence is provided standard through the fan coil board.
 - b) Automatic outdoor-fan motor protection.
 - c) System diagnostics.
 - d) Compressor motor current and temperature overload protection.
 - e) Outdoor fan failure protection.
- h. Electrical Requirements:
 - 1) Unit electrical power shall be a single point connection.
 - 2) Unit control voltage to the indoor-fan coil shall be 24 VDC.
 - 3) All power and control wiring must be installed per NEC and all local

- electrical codes.
- 4) Unit shall have high-and low-voltage terminal block connections.
- i. Special Features (Field Installed):
 - 1) Low-Ambient Kit: Control shall regulate fan-motor cycles in response to saturated condensing temperature of the unit. The control shall be capable of maintaining a condensing temperature of $100^{\circ}\text{F} \pm 10^{\circ}\text{F}$, with outdoor temperatures to 20°F . Installation of kit shall not require changing the outdoor fan motor.
 - 2) Crankcase Heater.
- j. Warranty:
 - 1) 1-Year parts and 5-Year compressor warranty.

2.3 REFRIGERATION

A. VRV Outdoor Condensing Units, Air Cooled, Three Pipe Heat Recovery, 6 To 20 Tons:

1. Installation Requirements:
 - a. Pre-bid training: The mechanical contractor shall bid this project with complete knowledge of the HVAC system requirements. Mechanical contractor shall submit training certificate with bid form indicating estimator has received training by the manufacturer's representative.
 - b. Post-bid training: The system shall be installed by a factory-trained contractor. Within 30 days of award of contract, the installing contractor shall be required to submit training certification proof to the general contractor.
 - c. Prior installation experience: The installing contractor shall be required to have installed no less than **[four]** heat recovery systems prior to date of bid. Multiple units installed at a single location shall constitute one system.
2. Warranty:
 - a. Special Warranty: Manufacturer's standard terms and conditions in which manufacturer agrees to repair or replace components of condensing units, fan coils, and controls that fail in materials or workmanship within specified warranty period.
 - 1) General Warranty Period: One year from date of Substantial Completion.
 - 2) Compressor Warranty Period: Six years from date of Substantial Completion.
3. System Description: The variable capacity, heat recovery air conditioning system shall be a Variable Refrigerant Volume (simultaneous heat and cool model) split system as specified. The system shall consist of multiple evaporators, branch selector boxes, joints and headers, a three pipe refrigeration distribution system using PID control, and outdoor unit. Two-pipe systems requiring separation of mixed phase refrigerant into gas and liquid refrigerant are not acceptable due to lack of superheating of refrigeration hot gas.
 - a. Operating range:
 - 1) The operating range in cooling will be $23^{\circ}\text{Fdb} - 110^{\circ}\text{Fdb}$.
 - 2) The operating range in heating will be $0^{\circ}\text{Fdb} - 77^{\circ}\text{Fdb}$.
 - 3) Simultaneous cooling/heating operating range will be $22^{\circ}\text{Fwb} - 60^{\circ}\text{Fwb}$.
4. The outdoor unit is a direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioning system with variable speed driven compressors using R-410A refrigerant.

- a. Unit Cabinet: The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- b. Compressor: Inverter scroll compressors shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor shall be controlled to eliminate deviation from target value.
 - 1) The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” with a maximum speed of 7,980 rpm. Fixed speed compressors designed for loading and unloading of scroll in pulse-width-modulation fashion (i.e. “digital” scroll) shall not be allowed.
 - 2) Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
 - 3) The system capacity control range shall be as 6% to 100% full capacity.
 - 4) Each non-inverter compressor shall also be of the hermetically sealed scroll type.
 - 5) Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
 - 6) Oil separators shall be standard with the equipment together with an intelligent oil management system.
 - 7) In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.
 - 8) In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.
- c. Condenser Coil:
 - 1) Continuous heating: Condenser coil shall be designed with multiple circuits such that one half of the condenser coil shall operate in heating mode while the other half is in defrost mode.
 - 2) The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
 - 3) The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
 - 4) The fins are to be covered with an anti- corrosion acrylic resin and hydrophilic film type E1.
 - 5) The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.
- d. Fan(s): The condensing unit shall consist of one or more propeller type, direct-drive fan motors that have multiple speed operation via a DC (digitally commutating) inverter.

- 1) The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate for louvers, screens and field applied duct for indoor mounting of condensing units.
 - 2) Nominal sound pressure levels shall not exceed 63dB(A) while in heating mode.
 - 3) The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
 - 4) The fan motor shall be provided with a fan guard to prevent contact with moving parts.
 - e. Safeties: The following safety devices shall be included on the condensing unit:
 - 1) High pressure switch
 - 2) Control circuit fuses
 - 3) Crankcase heaters
 - 4) Fusible plug
 - 5) High pressure switch
 - 6) Overload relay
 - 7) Inverter overload protector
 - 8) Thermal protectors for compressor and fan motors
 - 9) Over current protection for the inverter and anti-recycling timers.
 - 10) Tamper proof port caps.
 - f. Operation of the system shall permit either individual cooling or heating of each fan coil simultaneously or all of the fan coil units associated with one branch cool/heat selector box (BSVQ). Each fan coil or group of fan coils shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface.
 - g. Branch selector (BS) boxes shall be located as shown on the drawing. The branch selector boxes shall have the capacity to control up to 60 MBH (cooling) downstream of the BS box. The BS box shall consist of five electronic expansion valves, tube-in-tube heat exchanger, refrigerant control piping and electronics to facilitate communications between the BS box and main processor and between the BS box and fan coils. The BS box shall control the operational mode of the subordinate fan coils. The use of five EEV's ensures continuous heating during defrost, no heating impact during changeover and reduced sound levels. Refrigerant connections shall be brazed type.
 - 1) Use of multi-port branch selector boxes shall not be acceptable.
 - 2) The unit shall not require any condensate drainage connection.
5. VRV Indoor Units:
 - a. Typical requirements for all fan coils:
 - 1) Copper tube with aluminum waffle fin DX coil, designed and rated for use with R-410A.
 - 2) Electronic modulating expansion valve, 2000-step minimum.
 - 3) PID Microprocessor controls.
 - 4) Return air thermister.
 - 5) Liquid and suction gas refrigerant thermisters.
 - b. High-wall type to include the following:
 - 1) Two-speed direct-drive cross-flow fan with thermally protected DC motor.
 - 2) Midew-resistant, washable resin filter.

- 3) Auto-swing louver.
- 4) Condensate pan.
- 5) Microprocessor controls.
- 6) Options as scheduled.
- c. Slim ducted type to include the following:
 - 1) Two-speed direct-drive sirocco fan with thermally protected DC motor.
 - 2) DX coil rated for use with R-410A.
 - 3) Electronic modulating expansion valve.
 - 4) Built-in condensate drain pump (with 21-inch lift and overflow switch).
 - 5) Return air thermister.
 - 6) Liquid and suction gas refrigerant thermisters.
 - 7) Mildew-resistant, washable resin filter.
 - 8) Field convertible rear/bottom RA connection.
 - 9) Microprocessor controls.
 - 10) Options as scheduled.
- d. Ceiling cassette type designed for lay-in application as scheduled, or approved equivalent, to include the following:
 - 1) Two-speed direct-drive turbo fan with thermally protected DC motor.
 - 2) Impact-resistant, washable face panel.
 - 3) Four-way discharge louvers (motorized).
 - 4) Concentric return air panel.
 - 5) DX coil rated for use with R-410A.
 - 6) Electronic modulating expansion valve.
 - 7) Built-in condensate drain pump (with 21-inch lift and overflow switch).
 - 8) Washable resin filter and front grille.
 - 9) Knock-out for outside air intake. Contractor shall furnish field fabricated intake connection.
 - 10) (2) knock-outs for field SA duct connection (FXFQ only).
 - 11) Microprocessor controls.
 - 12) Options as scheduled.
- e. Ceiling suspended type to include the following:
 - 1) Two-speed direct-drive sirocco fan with thermally protected DC motor.
 - 2) DX coil rated for use with R-410A.
 - 3) Electronic modulating expansion valve.
 - 4) Return air thermister.
 - 5) Liquid and suction gas refrigerant thermisters.
 - 6) Washable resin filter and front grille.
 - 7) Microprocessor controls.
 - 8) Options as scheduled.
- f. Floor w/ cabinet type to include the following:
 - 1) Two-speed direct-drive sirocco fan with thermally protected DC motor.
 - 2) DX coil rated for use with R-410A.
 - 3) Electronic modulating expansion valve.
 - 4) Return air thermister.
 - 5) Liquid and suction gas refrigerant thermisters.
 - 6) Powder-coated steel enclosure with toe-kick inlet and top discharge.
 - 7) Washable resin filter.
 - 8) Microprocessor controls.
 - 9) Options as scheduled.
- g. DC ducted type with ECM motor to include the following:

- 1) Variable speed direct-drive sirocco fan with thermally protected DC electrically commutated motor (ECM) motor. Fan motor shall be pre-programmed with fan curve to automatically modulate the fan speed as necessary maintain a consistent airflow setpoint as the external static pressure changes (i.e. due to filter loading). Multispeed PSC motors will not be allowed.
 - 2) DX coil rated for use with R-410A.
 - 3) Electronic modulating expansion valve.
 - 4) Built-in condensate drain pump (with 21-inch lift and overflow switch).
 - 5) Return air thermister.
 - 6) Liquid and suction gas refrigerant thermisters.
 - 7) Microprocessor controls.
 - 8) Options as scheduled.
 - h. Floor w/o cabinet type to include the following:
 - 1) Two-speed direct-drive sirocco fan.
 - 2) DX coil rated for use with R-410A.
 - 3) Electronic modulating expansion valve.
 - 4) Toe-kick inlet and top duct connection.
 - 5) Washable resin filter.
 - 6) Microprocessor controls.
 - 7) Options as scheduled.
 - i. Low static ducted to include the following:
 - 1) Two-speed direct-drive sirocco fan with thermally protected DC motor.
 - 2) DX coil rated for use with R-410A.
 - 3) Electronic modulating expansion valve.
 - 4) Washable resin filter.
 - 5) Microprocessor controls.
 - 6) Options as scheduled.
6. Controls:
- a. General:
 - 1) The temperature control range shall cover from 60 F to 90 F.
 - 2) For compatibility, all controllers shall be of the same manufacturer as the indoor and outdoor units.
 - b. Navigation Zone Controller – Wired Remote Controller
 - 1) The navigation zone controller shall be able to control 1 group (maximum of 16 fan coil units) and shall be able to function as follows:
 - a) Operation:
 - i. Start/Stop
 - ii. Operation Mode (cool/dry/heat/auto/fan)
 - iii. Automatic changeover
 - iv. Temperature Setting
 - v. 60°F – 90°F Set Point Range
 - vi. Fan Speed
 - vii. Airflow Direction
 - viii. Individual permit/prohibit buttons
 - b) Monitoring:
 - i. Status.
 - ii. Malfunction Flashing.
 - iii. Error Code

- iv. Filter Sign
 - v. Operation Mode
 - vi. Temperature Setpoints and setback setpoints
 - vii. Room Temperature Setting
 - viii. Permit/Prohibit Selection
 - ix. Fan Speed
 - x. Airflow Direction
 - c) Scheduling:
 - i. 7-day time clock, with selectable 12-hour / 24-hour display.
 - ii. 7-day, 5+2, and 5+1+1 weekly schedule.
 - iii. 5 actions per day with independent setpoints
 - iv. 48 hour clock/calendar backup
 - 2) The controller shall have a maximum wiring length of 1,640 feet.
 - 3) The controller shall have a self-diagnosis function that constantly monitors the system for malfunctions (total of 80 components).
 - 4) The controller shall be able to immediately display fault location and condition.
 - 5) Backlit LCD digital display will allow the temperature to be set in 1°F units.
 - 6) Controller shall be furnished with a integral temperature sensor.
 - 7) The controller shall monitor room temperature and preset temperature by microcomputer and can select cool/heat operation mode automatically.
 - 8) The controller shall allow the user to select cool / heat / fan operation mode with indoor remote controller of choice without using the cool / heat selector.
- c. Individual Zone Controller – Wired Remote Controller
- 1) The wired remote controller shall be able to control 1 group (maximum of 16 fan coil units) and shall be able to function as follows:
 - a) Operation:
 - i. Start/Stop
 - ii. Operation Mode
 - iii. Temperature Setting
 - iv. 60°F – 90°F Set Point Range
 - v. Fan Speed
 - vi. Airflow Direction
 - b) Monitoring:
 - i. Status.
 - ii. Malfunction Flashing.
 - iii. Malfunction Content
 - iv. Filter Sign
 - v. Operation Mode
 - vi. Temperature Setting
 - vii. Permit/Prohibit Selection
 - viii. Fan Speed
 - ix. Airflow Direction
 - c) Scheduling:
 - i. ON/OFF Timer
 - 2) The controller shall have a maximum wiring length of 1,640 feet.
 - 3) The controller shall have a self diagnosis function that constantly monitors the system for malfunctions (total of 80 components).
 - 4) The controller shall be able to immediately display fault location and condition.

- 5) An LCD digital display will allow the temperature to be set in 1°F units.
 - 6) The controller shall be equipped with a thermostat sensor in the remote controller making possible more comfortable room temperature control.
 - 7) The controller shall monitor room temperature and preset temperature by microcomputer and can select cool/heat operation mode automatically (heat recovery outdoor unit only).
 - 8) The controller shall allow the user to select cool / heat / fan operation mode with indoor remote controller of choice without using the cool / heat selector.
- d. Individual Simplified Zone Controller - Wired Remote Controller Without Timer
- 1) The simplified wired remote controller shall be able to control 1 group (maximum of 16 fan coil units) and shall be able to function as follows:
 - a) Operation:
 - i. Start/Stop
 - ii. Operation Mode
 - iii. Temperature Setting
 - iv. 60°F – 90°F Set Point Range
 - v. Fan Speed
 - b) Monitoring:
 - i. Status.
 - ii. Malfunction Flashing.
 - iii. Malfunction Content
 - iv. Filter Sign
 - v. Operation Mode
 - vi. Temperature Setting
 - vii. Permit/Prohibit Selection
 - viii. Fan Speed
 - 2) The controller shall have a maximum wiring length of 1,640 feet.
 - 3) The controller shall have a self-diagnosis function that constantly monitors the system for malfunctions (total of 80 components).
 - 4) The controller shall be able to immediately display fault location and condition.
 - 5) An LCD digital display will allow the temperature to be set in 1°F units.
 - 6) The controller shall monitor room temperature and preset temperature by microcomputer and can select cool/heat operation mode automatically (heat recovery outdoor unit only).
 - 7) The controller shall allow the user to select cool / heat / fan operation mode with indoor remote controller of choice without using the cool / heat selector.
- e. iTouch controller: Central controller with touch-sensitive full-color LCD screen, capable of providing central control of up to 64 fan coil groups (expandable to 128 groups).
- 1) Coordinate 24VAC power required (40VA minimum) with electrical contractor.
 - 2) Furnish install box for recessed wall mounting.
 - 3) Standard functions available shall include:
 - a) Individual and multiple group on/off control
 - b) Space temperature setpoint adjustment
 - c) Fan speed adjustment
 - d) External contact for emergency shut-down of all connected indoor units

- e) Iconic display of unit operation
 - f) System diagnostics
 - g) Weekly and holiday scheduling.
 - 4) Options to be provided:
 - a) Furnish with Ethernet connection for remote monitoring through web-based and email notification software. Static IP address shall be furnished by the owner.
 - f. BACnet Gateway:
 - 1) BACnet Gateway shall be able to control minimum 128 indoor unit groups as standard, and shall be expandable to control 256 indoor unit groups.
 - 2) Gateway shall be classified as a BACnet application specific controller (B-ASC), and shall support BACnet over IP. Gateway shall be a freestanding hardware device, and shall not require the use of a personal computer or separate centralized controller (unless indicated otherwise on the plans).
 - 3) Control and monitoring points shall be as follows:
 - a) Operation:
 - i. Start/Stop.
 - ii. Operation Mode.
 - iii. Setpoint Adjustment
 - iv. Room Temperature
 - v. Fan Speed.
 - vi. Filter Sign Reset
 - vii. Airflow Direction
 - viii. Forced Stop
 - ix. Rejection of Temperature Setting at Local Controller
 - x. Rejection of Mode Setting at Local Controller
 - xi. Rejection of On/Off at Local Controller
 - b) Monitoring:
 - i. On/Off Status
 - ii. Error Status Report
 - iii. Error Code Report
 - iv. Filter Sign Report
 - v. Operation Mode Status Report
 - vi. Airflow Direction Status
 - vii. Temperature Setting
 - viii. Room Temperature Report
 - ix. Fan Speed
 - x. Compressor Status
 - xi. Expansion Valve Status
 - xii. Fan Status
 - 4) Unit shall operate on 24VAC power supply. Transformer shall be furnished to electrical contractor for installation (75VA minimum).
 - g. Control wiring: The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation. Cable shall be 16 AWG, non-polarity, non-shielded, stranded 2 conductor cable.
7. Installation:
- a. Install unit's level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

- b. Vibration Isolation: Mount roof-mounted condensing units on rubber pads with a minimum deflection of **1/4 inch (6.35 mm)**. Vibration isolation devices and installation requirements are specified in Section "Heating, Ventilating, and Air Conditioning Vibration Isolation".
 - c. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.
8. Connections:
- a. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.
 - b. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories.
 - c. All branch take-offs shall be made with manufacturer recommended joints. Tee fitting takeoffs shall not be allowed.
 - 1) Fittings shall be installed in horizontal plane (maximum +/-15 degree rotation allowed), or in vertical orientation (i.e. main pointing strait up and branches point strait down, or vice versa).
 - d. Refrigerant piping shall be insulated with pre-formed elastomeric pipe insulation. Minimum thickness shall be determined by the local authority having jurisdiction.
 - 1) Liquid, suction and hot gas (where applicable) lines shall be insulated individually.
 - 2) Oil equalization lines between multiple condensing units shall be insulated.
 - 3) Securely install pipe insulation sleeves provided with equipment at each flair fitting.
 - e. Refrigerant driers, vibration isolators, sight glasses, and shut-off valves external to the condensing unit shall not be required for proper system operation.
 - f. Piping installation shall comply with all federal, state and local regulations and industry guidelines. In addition, the following practices shall be followed.
 - 1) All piping shall be stored with ends sealed to prevent entry of moisture and debris.
 - 2) A pipe cutter specific to the piping material applied shall be used.
 - 3) All factory and field cut tube ends shall be de-burred and cleaned.
 - 4) Flared fittings shall be formed using tools recommended by the equipment manufacturer.
 - 5) Flare nuts shall be tightened with torque wrench recommended by the equipment manufacturer.
 - 6) Dry nitrogen shall be used during all brazing to prevent oxidation.
 - 7) Piping shall be installed as straight as possible. Changes in direction shall be made with tubing bender, or with long radius elbow fittings.
 - 8) Piping shall be supported within 36 inches from each fan coil unit and branch selector box. Additional supports shall be provided as required by local codes, specifications, and details.
9. Field Quality Control:
- g. Perform the following field tests and inspections and prepare test reports:
 - 1) Perform electrical test and visual and mechanical inspection.
 - 2) Pressure testing requirements: Three-step pressure test shall be performed per the following:
 - a) Step 1 - leak check at 149 psi for a minimum of 3 minutes.
 - b) Step 2 - leak check at 312 psi for a minimum of 5 minutes.

- c) Step 3 - leak check at 550 psi for a minimum of 24 hours.
- 3) Evacuation requirements: A vacuum pump designed specifically for use with R-410A shall be used to triple-evacuate the system per the following:
 - a) Step 1: Evacuate the system to 4,000 microns and maintain for 20 minutes.
Step 2: Break vacuum with dry nitrogen to a pressure of 2-3 psi, and maintain for 15 minutes.
Step 3: Evacuate the system to 1,500 microns and maintain for 20 minutes.
Step 4: Break vacuum with dry nitrogen to a pressure of 2-3 psi, and maintain for 15 minutes.
Step 5: Evacuate the system to 500 microns and maintain for 60 minutes.
- 4) Pre-commissioning: Complete pre-commission checklist furnished by the equipment manufacturer, and submit to the engineer for record. System start up shall not take place until the start-up forms have been completed and signed by the contractor.
 - a) To determine additional refrigerant charge required, the installing contractor shall record on a per-system basis, the total linear feet of liquid line installed, broken out per pipe size.
 - b) Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
 - c) Remove and replace malfunctioning condensing units and retest as specified above.

10. Startup Service

- a. Prior to startup, the contractor shall complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1) Inspect for physical damage to unit casing.
 - 2) Verify that access doors move freely and are weather tight.
 - 3) Clean units and inspect for construction debris.
 - 4) Verify that all bolts and screws are tight.
- b. The system shall be started up by the equipment supplier's factory-trained technician. The HVAC and electrical contractor shall be on site to support the startup process. All piping modifications and high and low voltage wiring modifications shall be made by the contractor at no additional cost.

11. Demonstration

- a. The manufacturer's representative shall train the Owner's maintenance personnel to adjust, operate, and maintain condensing units.

2.4 EXHAUST FANS

A. Centrifugal In-line Fan (square housing)

- 1. Description:
 - a. Fan shall be duct mounted, belt driven centrifugal square inline.
- 2. Certifications:
 - a. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air

performance.

3. Construction:
 - a. The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18 gauge galvanized steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Pivoting motor plate shall utilize threaded L-bolt design for positive belt tensioning. Housing shall be pre-drilled to accommodate universal mounting feet for vertical or horizontal installation. Unit shall bear an engraved aluminum nameplate.
 4. Wheel:
 - a. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96.
 5. Motor:
 - a. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.
 6. Bearings:
 - a. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a pillow block housing selected for a minimum L10 life in excess of 100,000 hours at maximum cataloged operating speed.
 7. Belts and Drives:
 - a. Belts shall be oil and heat resistant, non-static type. Drives shall be precision-machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.
 8. Manufacturer, Capacity & Accessories:
 - a. See Drawings
- B. Utility Vent Set (general use):
1. Description:
 - a. Fan shall be a single width, single inlet, forward curved steel wheel, belt driven centrifugal vent set.
 2. Certifications:
 - a. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.
 3. Construction:
 - a. The fan shall be of bolted and welded construction utilizing corrosion resistant

fasteners. The scroll wrapper and side panels shall be heavy gauge steel and the scroll side panels shall be minimum 12 gauge steel. The fan housing shall be field rotatable to any one of eight discharge positions. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.

4. Wheel:
 - a. Wheel shall be centrifugal forward curved type. Wheel hub shall be keyed and securely attached to the fan shaft. Wheel shall utilize a one piece aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96.
5. Motor:
 - a. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.
6. Blower Shaft:
 - a. Blower shaft shall be AISI C-1045 hot rolled and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum RPM.
7. Bearings:
 - a. Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball or roller type in a heavy duty pillowblock housing selected for a minimum L10 life in excess of 100,000 hours at maximum cataloged operating speed.
8. Belts and Drives:
 - a. Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.
9. Manufacturer, Capacity & Accessories:
 - a. See Drawings.

2.5 AIR DISTRIBUTION

A. Ductwork:

1. Low pressure ductwork shall be fabricated from galvanized sheet metal, unless otherwise indicated. Construction requirements shall be in accordance with SMACNA - HVAC Duct Construction Standards, metal and flexible, latest edition. All sheet metal ductwork shall be sealed with McGill United Sheet Duct Sealer or equal, in accordance with the International Energy Compliance Code, latest edition. Adjustable (twist) elbows are not allowed. Low pressure ductwork shall be constructed to the following SMACNA static pressure standards:
 - a. Supply air ductwork = 2" W.G.
 - b. Return, Exhaust, Outside Air Intake ductwork = 1" W.G.

- c. Vehicle Exhaust Ductwork = 4" W.G.
- 2. Low pressure ductwork located exposed in exposed ceiling areas, shall be spiral type ducts with a "paint-grip" finish, on ductwork and associated fittings that can be painted.
 - a. Joints: 0" to 20" diameter, interior slip coupling beaded at center, fastened to duct with screws and with sealing compound applied continuously around joint before assembling and after fastening. Sealing compound shall be applied in an evenly and professional manner.
 - b. Joints 22" – 72" diameter, use 3-piece, gasketed, flanged joints consisting of 2 internal flanges (with integral mastic sealant) split to accommodate minor differences in duct diameter, and one external closure band designed to compress gasketing between internal flanges. Manufacturer shall be Ductmate Spiralmate or equal.
 - c. All takeoff or branch entrances shall be by means of factory-fabricated fittings. Field taps shall not be allowed.
- 3. Low pressure ductwork which is exposed or located in mechanical rooms shall be fabricated from galvanized sheet metal. Construction requirements shall be in accordance with SMACNA HVAC Duct Construction Standards, metal and flexible, latest edition.
- 4. Low or medium pressure, double wall acoustically insulated ductwork shall have a minimum 1" insulation, & perforated metal lining, & shall be McGill Acousti-k27, Metaltec, or equal.
- 5. Ductwork penetrating protective elements of fire-rated corridor walls, with no openings into corridor, shall be constructed of minimum 26 gauge galvanized steel.
- 6. Exterior exposed ductwork shall be fabricated from galvanized sheets. All joints and seams shall be standing-seam type with sealing mastic to provide watertight construction. All ductwork shall be internally insulated as hereinafter specified. All exposed surfaces shall be primed and painted two coats of exterior enamel paint, color as selected by the Architect.
- 7. Shower and locker room exhaust ductwork shall be constructed of galvanized sheet metal, in accordance with SMACNA standards.
- 8. Flexible ducts shall be listed per UL-181 standard as Class 1 flexible, acoustical insulated air duct and complying with NFPA Standards 90A and 90B. Ducts shall be insulated with a minimum R-5 value, and shall have a maximum vapor transmission value of .05 perms. Ducts shall be factory made with and composed of: a PE liner duct permanently bonded to a coated spring steel wire helix. Duct shall be chlorine free and carry a ten-year warranty for the labor to replace the duct should there be a factory defect. Low permeability outer vapor barrier of fiberglass bidirectional reinforced metalized laminate shall complete the composite. Pressure rating shall be 6" w.g. and maximum length shall be 6 feet. Attach to duct take-off, diffuser, register, or grille only, with nylon or stainless steel duct clamp or tie. Flexmaster 1-M, Thermaflex M-KE (R6.0), or approved equal.

B. Duct Accessories:

- 1. Turning vanes shall be installed in all rectangular or square elbows. Vanes shall be installed in vane side rails. Vanes shall be single wall vanes, and be fabricated and installed per SMACNA standards.

2. Volume dampers shall be fabricated from galvanized steel in accordance with SMACNA standards. Dampers shall have a continuous galvanized steel shaft on ducts 13" diameter or larger, with damper regulators and end bearings. Dampers located above inaccessible ceilings (hard ceilings) shall be furnished with concealed ceiling damper regulators. Dampers shall be pressure rated equal to the design duct pressure rating. Dampers shall be provided at all diffuser and supply/exhaust grille takeoffs, regardless if indicated on the plans. Dampers are not required on the return air takeoffs unless specifically indicated.
 3. Flexible connections shall be provided at all rotating fan equipment. Connectors shall be of fire, water, and weather resistant material.
 4. Fire dampers shall be UL-labeled with frame, locking assembly, accordion style folded blades, and fusible link. Dampers shall be Style B with blades stored outside of the air stream. Provide duct inspection door at each fire damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel.
 5. Combination smoke and fire dampers are to be fusible link type with factory sleeve and electric operator located exterior to duct 120 V. operator to be spring return, fail closed with 212 degrees F link and UL label. Provide duct inspection door at each damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel. Belimo operators/actuators only.
 6. Smoke dampers are to be ultra-low leakage (less than 4CFM/ft²) type with factory sleeve and electric operator located exterior to duct 120 V. operator to be spring return, fail closed and UL label. Provide duct inspection door at each damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel. Belimo operators/actuators only.
 7. A plastic flex elbow support by Flexible Technologies Inc., Titus FlexRight, or approved equal, is required at all flex duct elbows supplying ceiling diffusers & return grilles. Elbow support shall be fully adjustable, or be of universal design, to support flexible diameters 6" – 16", sized to fit flex duct. Elbow supports shall be UL rated for use in return air plenum spaces. At the Contractor's option, a hard elbow may be used in lieu of a flexible elbow.
- C. Diffusers, Registers, Louvers, Grilles, Weathercaps:
1. See Drawings for requirement.
- D. Duct Cleanliness:
1. Ductwork Delivery To Site
 - a. During ductwork being delivered from the premises of the manufacturer, care must be taken to prevent damage during transportation and off-loading.
 2. Temporary Storage
 - a. Job site duct material storage areas should be clean, dry, and located away from high

dust generating processes such as masonry or tile cutters, cutoff saws, drywall sanding, mortar and plaster mixers, roof pitch kettles, portable electric generators, and main walkways that will be constantly broom swept. The general contractor should designate a suitable area for temporary storage.

- b. To prevent ductwork material damage from standing water, storage locations should include pallets or blocking to keep fabricated metal ductwork above the floor surface. If there is a risk of water runoff from above or dusty areas cannot be avoided, coverage should be used to protect stored materials.
3. Installation
 - a. Before the installation of individual duct sections, they are to be inspected to insure that they are free from all debris.
 - b. All ductwork risers must be covered to prevent the entry of debris into the duct.
 - c. Downward facing and horizontal ductwork openings will not be required to be covered.
 - d. Access covers shall be firmly fitted in position on completion of each section of the work. Open ends on completed ductwork and overnight work-in-progress shall be sealed.
 - e. The working area should be clean and dry and protected from the elements.
 - f. The internal surfaces of the uninsulated ductwork shall be wiped to remove excess dust immediately prior to installation.

2.6 PIPING SYSTEMS

A. Refrigerant Piping:

1. Refrigerant piping shall be manufacturer's standard line sets, in lengths as required for proper installation. Coiling of excess tubing will not be acceptable.
2. Provide PVC sleeve and caulking at all refrigerant pipe penetrations of exterior walls.

B. Condensate Drain Piping:

1. Exterior to building, or located in plenum: Piping shall be Type L hard drawn copper, ASTM B88 with solder joints. Copper piping shall not be used on 90% condensing type equipment.
2. Interior: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints, grade 95TA, or shall be Schedule 40 PVC. Copper piping shall not be used on 90% condensing type equipment.

C. Pipe Hangers and Supports:

1. See Section 220100 for hanger and support requirements for piping systems. See drawings for seismic support requirements for piping systems.

D. Piping Accessories:

1. Piping Hydronic Thermometer: Thermometer shall be 3" bimetal dial thermometers with

recalibrator with a 0°F to 250°F range and 2°F scale and accurate within 1% of scale range. Thermometer shall be provided with an Vari-angle Form angle stem and thermowell. Thermometers shall be installed in the hydronic system in a neat workman like manner, aligned vertically and horizontally with other thermometers in the system. The thermometers shall be installed no higher than 9'-0" above finish floor and be readable from finish floor. Weiss instrument or approved equal.

2. Piping Hydronic Pressure Gauges: Pressure gauges shall be 4½" diameter, liquid filled gauges with ranges to meet 1.5 times the pressure ratings of the system its serving. Pressure gauges shall be provided with quarter turn ball valve isolation valves on the source side and on the bleed off line. Pressure gauges shall be installed in the hydronic system in a neat workman like manner, aligned vertically and horizontally with other pressure gauges in the system. The pressure sensors shall be installed no higher than 9'-0" above finish floor and be readable from finish floor. Weiss instrument or approved equal.
3. Air Vent: Non-modulating, high capacity, automatic type designed to purge free air from the system and provide positive shutoff at pressures up to 150 psig at a maximum temperature of 250°F. Vent shall be constructed of cast iron body and bonnet with stainless steel, brass, EPDM, and silicon rubber internal components.

E. Valves:

1. See Section 15200 for valve requirements.

2.7 INSULATION

A. General:

1. All insulation shall have composite fire and smoke hazard ratings, as tested by ASTM E-84, NFPA 255, and UL 723, not exceeding:

Flame Spread	25
Smoke Developed	50

B. Ductwork - External Insulation:

1. Insulation shall be fiberglass insulation with aluminum foil scrim kraft facing. All joints shall be taped with UL listed tape to provide a continuous vapor barrier. The following ducts shall be externally insulated:
 - a. Supply ducts in unconditioned spaces (unless internally insulated)
 - b. Return ducts in unconditioned spaces (unless internally insulated)
 - c. Combustion air ducts
 - d. Outside air intake ducts
 - e. Exposed ductwork located within conditioned spaces shall not be externally insulated
2. Insulation thickness & "R" values shall be as follows:
 - a. R-5 (2" thick) – ducts located in unconditioned spaces (such as above ceiling, but below roof insulation).

- b. R-8 (3" thick) – ducts located outside of the building's insulation envelope (such as above the attic insulation).

C. Ductwork - Internal Insulation:

- 1. Insulation shall be flexible fiberglass duct liner. Liner shall be attached with 100% coverage of manufacturers recommended adhesive and welded or mechanically fastened galvanized steel pins. All exposed edges of liner shall be coated with adhesive. Duct dimensions shown are net air side face-to-face of duct liner. The following ducts shall be internally insulated:
 - a. Supply and Return ducts within 15'-0" of air handler, fan coils, and heat recovery units.
 - b. Supply and Return ducts in mechanical rooms
 - c. Ducts as indicated on plans

D. Piping Insulation - Refrigerant Piping:

- 1. Insulation on refrigerant suction piping shall be one-piece preformed flexible formed tubing with built-in closed cell vapor barrier. Seal laps and butt joints with moisture resistant adhesive to provide a continuous vapor seal. Furnish ½" thick insulation for 1¼" and smaller pipe, and 1" thick insulation for pipe larger than 1½". Exterior insulation shall be coated with a weather resistant coating as recommended by insulation supplier. Insulation shall have a conductivity not exceeding 0.28 Btu-inch/hour-sq. ft.-°F.

E. Piping Insulation - Exterior (Outdoor) Piping:

- 1. Piping located outdoors shall be insulated as specified above. In addition, piping shall be covered with a weather-proof aluminum jacket, minimum 0.016" thick. Seam shall be located and sealed on bottom side of horizontal pipes. Valve handles and gauges shall be positioned on the bottom side of the pipe.

2.8 VIBRATION ISOLATION

A. General:

- 1. All rotating equipment and appurtenances connected to rotating equipment shall be vibration isolated from the supporting structure. No metal to metal contact will be permitted between fixed and floating parts. All metal isolators exposed to weather shall be hot dipped galvanized after fabrication. Piping connected to rotating equipment shall be hung with spring hangers for first 50 pipe diameters.

B. Floor Mounted Spring Isolators:

- 1. Isolators shall be free standing, laterally stable, and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter to operating spring height of 1.0 and an additional travel to solid equal to 50% of rated deflection.

C. Floor Mounted Neoprene Pads:

1. Isolators shall be neoprene waffle or combination neoprene and cork sandwich. Pads shall be sized and selected as per manufacturers loading requirements.

D. Spring Hangers:

1. Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional spring travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.

2.9 SEISMIC SUPPORTS

- A. All equipment, ductwork, and piping shall be seismically supported as required by the International Building Code, latest edition. Support details shall be as indicated on the Drawings.

2.10 CONTROL SYSTEM

A. General:

1. The Control Contractor shall be responsible for a complete and operable control system, including equipment, installation, and accessories required to perform the functions specified on the drawings. The Control Contractor shall supervise the installation of all control equipment and accessories and shall submit shop drawings of the proposed system for approval. See Division 230900 for additional information.
2. The Mechanical Contractor shall be responsible for installing all control valves, water flow switches, temperature wells, control dampers, and related equipment which is furnished by the Control Contractor.
3. The control system shall be basically electric, with supplementary electronic devices as required.
4. The Control Contractor shall be Carrier Control System by American Chiller, no alternates.

B. Control Equipment and Accessories:

1. Control Dampers:
 - a. All control dampers are to be furnished under this section, except those specified to be furnished with the air handling units. Damper blades shall be fabricated of 22-gauge galvanized sheet steel and frames shall be not less than 16-gauge galvanized steel. Blades shall be maximum 10 inches wide, 50 inches long, and shall be provided with neoprene gasketed edges and oilite bronze or nylon bearings. Dampers shall be ultra-low leakage, opposed blade type for proportional action and parallel blade type for two-position action. Leakage performance shall be maximum of 3 cfm per sq. ft. @ a pressure differential of 1" w.g. Provide damper operators for all motorized dampers and louvers. Submittals shall include leakage and pressure drop data for all control dampers. All outside air dampers shall fail closed.

2. Control Valves:
 - a. Control valves 2-1/2" and smaller shall be screwed, 3" and larger shall be grooved or flanged. Screwed valves shall be bronze or cast brass, grooved valves shall be ductile iron, and flanged valves shall be cast iron or cast steel. Three way valves shall have contoured plugs for linear flow characteristics and constant total flow throughout the stem travel. Straight-thru valves shall be single seated and have equal percentage characteristics for water service. Flat discs shall be used for on-off control only. All valves shall be stainless steel stems, replaceable seats, and self-adjusting Teflon or rubber packing. All heating control valves shall fail open.
3. Air Duct Smoke Detector:
 - a. Smoke detector shall be products of combustion detector and shall be UL listed. The unit shall be designed for detection of combustion gases, fire, and smoke in air ducts in compliance with NFPA Pamphlet 90A. The sheet metal contractor shall provide a minimum 18"x18" hinged access door, in inaccessible ceilings, for each detector that is furnished. The sheet metal contractor is also responsible for providing all necessary transitions in the ductwork for mounting of the duct detector.
4. Thermostats:
 - a. Thermostats installed on exterior walls shall be mounted on an insulating block, or on foam insulation filled J-box.
 - b. All thermostats shall have a mounting height of 46 inches, to the centerline of the device, unless otherwise noted on electrical drawings.
5. Equipment Control Schematics:
 - a. See Drawings for schematics and sequence of operations.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. General:

1. Install all materials and equipment as shown and in strict accordance with the applicable codes for the State and/or city. Plans do not attempt to show exact details of all piping and ductwork, and no extra payment will be allowed for offsets required due to obstructions by other trades. All work shall be done in a neat and orderly fashion and left in a condition satisfactory to the Architect/Engineer.
2. All piping shall be run parallel or perpendicular to established building lines. Install piping so as to allow for expansion. Install all valves with stems horizontal or above. Install air vents at all high points. Provide all piping which passes through walls, floors, or ceilings with standard weight pipe sleeves.

B. Insulation:

1. All piping insulation shall be applied over clean, dry surfaces after system has been pressure tested and any leaks corrected. Finished appearance of all insulation shall be

smooth and continuous. Provide coat of insulating cement where needed to obtain this result.

2. Flexible duct insulation shall be secured to duct surface with 4-inch wide bands of adhesive applied on maximum 18-inch centers. Additional galvanized tie-wire support shall be furnished as required and recommended by the insulation manufacturer.

C. Diffusers, Registers and Grilles:

1. All diffusers, grilles, and registers shall be installed tight on their respective mounting surfaces and shall be accurately centered on ceiling tile, recesses, windows, or doors.

D. Ductwork:

1. All sheet metal work shall be done by qualified, experienced mechanics in accordance with the requirements of ASHRAE and the latest edition of the applicable SMACNA Manual. All ductwork shall be installed in a neat and orderly manner, and shall be adequately supported to prevent vibration or sagging. All sheet metal ductwork shall be sealed with United-Sheet Metal Duct Sealer or equal.

E. Air Conditioning Units:

1. Units shall be installed approximately where shown on the plans to provide access space for filter changing, motor, drive and bearing servicing, and fan shaft and coil removing. Pipe drain pan connection through a running trap to floor drain. Unit shall not be operated until filters are installed. Isolate sheet metal ducts from all fans with flexible connectors.

F. Condensing Units/ Heat Pumps:

1. Units located on flat rooftops shall be provided with Miro Industries Model HD, or equal, heavy duty galvanized roof support with adjustable legs, sized 6 inches larger, in each direction, than equipment footprint.

END OF SECTION 230100

SECTION 230800 - COMMISSIONING OF HVAC

PART 1- GENERAL

1.1 DESCRIPTION

- A. The purpose of this section is to specify Division 23 responsibilities in the commissioning process.
- B. The systems to be commissioned are listed in Section 019113, 1.6.
- C. Commissioning requires the participation of Division 23 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 019113. Division 23 shall be familiar with all parts of Division 1 and shall execute all commissioning responsibilities assigned to them in the Contract Documents (Project Manual and Commissioning Plan).

1.2 RESPONSIBILITIES

- A. Mechanical, Controls and TAB Contractors: The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors of Division 23 are as follows (all references apply to commissioned equipment only):
 - 1. Include and itemize the cost of commissioning in the contract price.
 - 2. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
 - 3. Attend a commissioning scoping meeting and other meetings necessary to facilitate the Cx process.
 - 4. Contractors shall provide the CxA with normal cut sheets and shop drawing submittals of commissioned equipment.
 - 5. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of functional testing procedures.
 - a. Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
 - b. The Commissioning Authority may request further documentation necessary for the commissioning process.
 - c. This data request may be made prior to normal submittals.
 - 6. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - 7. Provide limited assistance to the CxA in preparing the specific Functional Acceptance Test (FAT) procedures. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
 - 8. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the prefunctional checklists from the CxA for all commissioned equipment. Submit to CxA for review and approval prior to startup. Refer to Section 019113 for further details on start-up plan preparation.
 - 9. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
 - 10. Address current A/E punch list items before functional testing. TAB shall be completed with discrepancies and problems remedied before Functional Acceptance Testing of the respective systems.

11. Provide skilled technicians to execute starting of equipment. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.
 12. Provide skilled technicians to assist the CxA in the functional testing. Provide training to the CxA on operation of equipment in order for the CxA to perform the functional testing. Assist the CxA in interpreting the monitored data, as necessary.
 13. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, PM and A/E.
 14. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
 15. Provide training for the Owner's operating staff using expert qualified personnel, as specified.
 16. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- B. Mechanical Contractor: The responsibilities of the HVAC mechanical contractor, during construction and acceptance phases in addition to those listed in (A) are:
1. Provide startup for all HVAC equipment, except for the building automation system.
 2. Assist and cooperate with the TAB contractor and CxA by:
 - a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
 - b. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
 3. List and clearly identify on the as-built drawings the locations of all airflow stations.
 4. Notify the PM and CxA, when startup of each piece of equipment and TAB will occur. Be responsible to notify the PM or CxA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CxA has the scheduling information needed to execute efficiently the commissioning process.
- C. Controls Contractor. The commissioning responsibilities of the controls contractor, during construction and acceptance activities in addition to those listed in (A) are:
1. Sequences of Operation Submittals: The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
 - a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
 - b. All interactions and interlocks with other systems.
 - c. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
 - d. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
 - e. Start-up sequences.
 - f. Warm-up mode sequences.
 - g. Normal operating mode sequences.
 - h. Unoccupied mode sequences.
 - i. Shutdown sequences.
 - j. Capacity control sequences and equipment staging.
 - k. Temperature and pressure control: setbacks, setups, resets, etc.

- l. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 - m. Effects of power or equipment failure with all standby component functions.
 - n. Sequences for all alarms and emergency shutdowns.
 - o. Seasonal operational differences and recommendations.
 - p. Initial and recommended values for all adjustable settings, set points and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
 - q. Schedules, if known.
 - r. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.
 2. Control Drawings Submittal
 - a. The control drawings shall have a key to all abbreviations.
 - b. The control drawings shall contain graphic schematic depictions of the systems and each component.
 - c. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 - d. Provide a full points list with at least the following included for each point:
 - 1) Controlled system
 - 2) Point abbreviation
 - 3) Point description
 - 4) Display unit
 - 5) Control point or set point (Yes / No)
 - 6) Monitoring point (Yes / No)
 - 7) Intermediate point (Yes / No)
 - 8) Calculated point (Yes / No)
- Key:

 - Point Description: DB temp, airflow, etc.
 - Control or Set Point: Point that controls equipment and can have its set point changed (OSA, SAT, etc.)
 - Intermediate Point: Point whose value is used to make a calculation, which then controls equipment (space temperatures that are averaged to a virtual point to control reset).
 - Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
 - Calculated Point: “Virtual” point generated from calculations of other point values.

The Controls Contractor shall keep the CxA informed of all changes to this list during programming and setup.
3. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.
4. Assist and cooperate with the TAB contractor in the following manner:
 - a. Meet with the TAB contractor prior to beginning TAB to review the TAB process and determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique

instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).

- b. For a given system, have all required prefunctional checklists, calibrations, startup and selected functional tests completed prior to TAB.
 - c. Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.
 5. Assist and cooperate with the CxA in the following manner:
 - a. Assist in the functional testing of all equipment specified in Section 019113, 1.6 that interfaces with the building automation system. Provide sufficient training to the CxA to enable the CxA to perform Functional Acceptance Testing in the event the controls contractor is absent.
 - b. Setup required trend logs as required by the CxA for Functional Acceptance Testing verification. These trends must be in place and recording for a minimum of one week prior to scheduled start of Functional Acceptance Testing for a given system. Trend all system inputs and outputs. These trends will be used during the Functional Acceptance Testing as an additional means of verifying morning warm-up and optimal start sequences of operation. Hard copies of monitored data must be in columnar format with time down the left column and at least five columns of point values on the same page, and/or in graphical format.
 6. The controls contractor shall perform point-to-point, calibration and prefunctional checkout procedures as described in Section 019113 and the Commissioning Plan document.
 7. Provide a signed and dated certification to the CxA and PM upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.
 8. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as specified in Section 230900 Direct Digital Controls.
 9. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air and building pressure).
- D. TAB Contractor: The duties of the TAB contractor, in addition to those listed in (A) are:
 1. Prior to start of TAB, submit written work plan to CxA and GC detailing procedures and methodologies to be used in the performance of TAB.
 2. Prior to start of TAB, attend TAB coordination meeting with CxA and Controls Contractor. This meeting is intended to ensure that controls functionality is sufficient to accomplish TAB in the manner described in the TAB work plan.
 3. A running log of events and issues shall be kept by the TAB field technicians. Submit reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CxA and PM at least once a week.
 4. Communicate in writing to the controls contractor all set point and parameter changes made or problems and discrepancies identified during TAB, which affect the control system setup and operation.
 5. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA.
 6. Provide the CxA with any requested data, gathered, but not shown on the draft reports.
 7. Provide a final TAB report for the PM, with a copy to the CxA.
 8. Assist in functional tests and checks on the original TAB as necessary.
- E. Mechanical Designer: Refer to Section 019113 for the responsibilities of the mechanical designer.

1.3 RELATED WORK

- A. Refer to Section 019113, Part 1.4 for a listing of all sections where commissioning requirements are found.

- B. Refer to Section 019113 Part 1.6 for systems to be commissioned.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Division 23 shall provide all test equipment necessary to fulfill the testing requirements of this Division.
- B. Refer to Section 01 9113 Part 2.1 for additional Division 23 requirements.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Division 23 shall provide submittal documentation relative to commissioning as required in this Section Part 1 and Section 019113.

3.2 STARTUP

- A. The HVAC mechanical and controls contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 019113. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and A/E. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

3.3 TAB

- A. Refer to the TAB responsibilities in Part 1.2 above.

3.4 FUNCTIONAL TESTS

- A. Refer to Section 019113 Part 1.6 for a list of systems to be commissioned and to Part 3.5 for a general description of the testing requirements.

3.5 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

- A. Refer to Section 019113 Part 3.6 for specific details on non-conformance issues relating to prefunctional checklists and tests.
- B. Refer to Section 019113 Part 3.5 for issues relating to functional tests.

3.6 OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.
- B. Division 23 shall compile and prepare documentation for all equipment and systems covered in Division 23 and deliver this documentation to the A/E for inclusion in the O&M manuals, according to this section and Division 1, prior to the training of owner personnel.
- C. Special Control System O&M Manual Requirements: In addition to documentation that may be specified elsewhere, the controls contractor shall compile and organize at minimum the following data on the control system in labeled 3-ring binders with indexed tabs.

1. Three copies of the controls training manuals in a separate manual from the O&M manuals.
 2. Operation and Maintenance Manuals containing:
 - a. Full as-built set of control drawings (refer to Submittal section above for details).
 - b. Full as-built sequence of operations for each piece of equipment.
 - c. Full points list.
 - d. Full print out of all schedules and set points after testing and acceptance of the system.
 - e. Full as-built print out of software program.
 - f. Electronic copy on disk of the entire program for this facility.
 - g. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.
 - h. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
 - i. Control equipment component submittals, parts lists, etc.
 - j. Warranty requirements.
 - k. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
 3. The manual shall be organized and subdivided with permanently labeled tabs for each of the following data in the given order:
 - a. Sequences of operation
 - b. Control drawings
 - c. Points lists
 - d. Controller / module data
 - e. Thermostats and timers
 - f. Sensors and DP switches
 - g. Dampers and damper actuators
 - h. Program setups (software program printouts)
 4. Field checkout sheets and trend logs should be provided to the CxA as requested.
- D. Special TAB Documentation Requirements: The TAB will compile and submit the following with other documentation that may be specified elsewhere in the *Specifications*.
1. Final report containing an explanation of the methodology, assumptions, test conditions and the results in a clear format with designations of all uncommon abbreviations and column headings.
 2. The TAB shall mark on the drawings where all traverse and other critical measurements were taken and cross-reference the location in the TAB report.

3.7 TRAINING OF OWNER PERSONNEL

- A. The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.
- B. Mechanical Contractor: The mechanical contractor shall have the following training responsibilities:
 1. The mechanical contractor shall provide designated Owner personnel training as described in the Project Manual.
 2. The mechanical contractor will provide the CxA with a training plan and agenda for review prior to the training sessions as described in Section 019113, Part 3.8.
- C. Controls Contractor: The controls contractor shall have the following training responsibilities:

1. The controls contractor shall provide designated Owner personnel training on the control system in this facility as described in the Project Manual. The intent is to instruct the Owner clearly and completely on all the capabilities of the control system.
2. Training Plan and Agenda: The CC will provide the CxA with a training plan and agenda for review prior to the training sessions as described in Section 019113, Part 3.8. This plan will include specific topics of training, such as use of the display, alarm and status descriptors, command execution, and trend log generation. All training materials (handouts, visual aids, etc...) are to be included. The CxA will review the plan and recommend acceptance to the A/E and PM.

3.8 DEFERRED TESTING

- A. Refer to Section 0191130, Part 3.9 for requirements of deferred testing.

3.9 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors will consist of the filled out start-up, initial checkout & prefunctional checklists, point-to-point verification, sensor calibration verification, and programming verification described in Section 019113, and the proposed training plan and agenda.

END OF SECTION 23 0800

SECTION 230900 – DIRECT DIGITAL CONTROLS

PART 1 – GENERAL

1.1 GENERAL

A. Work Included:

1. Furnish all labor, materials, equipment, and service necessary for a complete and operating Building Control System (BCS), utilizing Direct Digital Controls (DDC) as shown on the drawings and described herein. The BCS shall perform control algorithms, calculations and all monitoring functions. The BCS shall provide operator interaction and dynamic process manipulation, including overall system supervision, coordination and control. This shall include HVAC control, metering, energy management, alarm monitoring, and all trending, reporting and maintenance management functions related to normal building operations all as indicated on the drawings or elsewhere in this specification.

B. Related Work:

1. Products furnished but not installed under this sections:
 - a. Section 230100 – Mechanical:
 - 1) Automatic Dampers (not specifically specified with the equipment)
 - b. Section 260000 – Electrical:
 - 1) Wiring and conduit required for dedicated 115 VAC outlets at the Operator Interfaces and accessories.
 - 2) Duct Smoke Detectors with contacts for use by this contractor.
 - 3) Wiring of power feeds through all disconnects, starters, and variable speed controllers to electric motors.
2. Products installed but not furnished under this section:
 - a. Section 230100 – Application Specific or Product Integrated Controls (PIC) for Equipment by this supplier
 - 1) Interconnect PIC equipment to BCS bus
 - b. Section 230100 – Mechanical
 - c. Thermostats

C. System Description:

1. General Requirements:
 - a. Provide and install a dedicated, stand-alone automatic Direct Digital Control system complete with all required software and hardware. This system will directly control all specified mechanical equipment, including VAV boxes, heat pumps, fans, duct coils, heat recovery units, pumps, cooling towers, central chiller plant machinery, etc.
 - b. The operator workstation shall run on a personal computer (PC) with a color monitor, mouse, keyboard, and printer. The operator workstation will allow a user to interface with the network via graphic and/or text format as described in the Product section Part 2.

- c. The controls contractor shall assume complete responsibility for the entire controls system as a single source. He shall certify that he has on staff under his direct employ on a daily basis, factory trained technical personnel. These employees shall be qualified to project manage, engineer, commission, and service all portions of the control system.
 - d. The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate.
2. Basic System Features:
- a. Zone by zone direct digital logic control of space temperature, scheduling, optimum starting, equipment alarm reporting, and override timers for after-hours usage. A zone is the area served by one VAV box, heat pump, unit ventilator, fan coil, etc.
 - b. Operator Interface software shall be a web-browser application. The server software shall be multi-tasking, capable of executing and displaying multiple instances in individual windows while running concurrently with other Windows programs such as word processors or database programs. Operation of the terminal software shall be simple and intuitive.
 - c. Complete energy management firmware, including self-adjusting optimum start, power demand limiting, global control strategies and logging routines for use with total control systems. All energy management firmware shall be resident in field hardware and not dependent on the Operators Terminal for operation. Operators terminal software is to be used for access to field based energy management control firmware only.
 - d. Priority password security systems to prevent unauthorized use. Each user shall have an individual password, or users can be assigned to a group password. Each user shall be assigned which control functions they have access to.
 - e. Equipment monitoring and alarm function including information for diagnosing equipment problems and alarm dial out to remote sites or pagers.
 - f. The complete system, including, but not limited to zone controllers, field installed controllers and operator's terminals shall auto-restart, without operator intervention, on resumption of power after a power failure. Database stored in field installed controller memory shall be battery backed up for a minimum of 1 year. Batteries on unitary controllers shall not be allowed.
 - g. Modular system design of proven reliability.
 - h. Each field panel capable of independent control.
 - i. All software and/or firmware interface equipment for connection to remote monitoring station from field hardware or the operator's terminal.
 - j. The system shall be capable of recording equipment runtime totalization of fans, heaters, boilers, etc., and also capable of alarm generation and alarm dial out to remote sites.
 - k. Communication wiring for field controllers shall not be run in star patterns.
 - l. All DDC hardware and software shall be designed and manufactured by U.S. corporations. All hardware shall be Listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the U.L. standard for safety 916, with integral labels showing rating.

D. Quality Assurance

1. Responsibility:
 - a. The supplier of the Building Control System shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished by him.
 2. Component Testing:
 - a. Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. The manufacturer prior to shipment shall individually test each and every controller, sensor, and all other DDC components.
 3. Tools, Testing and Calibration Equipment:
 - a. The Building Control System supplier shall provide all tools, testing and calibration equipment necessary to ensure reliability and accuracy of the control system.
 4. Installer Qualification:
 - a. The installer shall be certified as a trained, approved installer by the Building Controls Systems Manufacturer. The certification shall be for the type and version of the product to be installed in this project.
 - b. The installer shall have completed the Building Control Systems Manufacturer's classes on the control system. The installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.
 - c. The installer shall have a minimum of five years documented experience in Building Control Systems installations and be approved by the Manufacturer or their authorized Distributors.
 - d. Controls shall be Carrier Direct Digital Controls by American Chiller of Boise, as part of the existing City's DDC system.
 5. Product Qualification:
 - a. All products used in this installation shall be new, currently under manufacture, and shall not be used as a test site for any new products unless explicitly approved by the Engineer in writing. Spare parts shall be available for at least 5 years after completion of this contract.
 - b. All controllers shall be capable of containing and executing factory designed and tested, pre-engineered control algorithms. Factory tested algorithms shall be utilized to meet the sequence of operation (except as noted).
 - c. All products shall be available to multiple installers. The manufacturer shall have at least 3 installation and service providers within 100 mile radius.
- E. Reference Standards:
1. The latest edition of the following standards and codes in effect and amended as of date of supplier's purchase order, and any subsections thereof as applicable, shall govern design and selection of equipment and material supplied:
 - a. ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers) Standards 135 (BACnet), 90.1 and 62.99
 - b. (Directive 89/336/EEC (European CE Mark).
 - c. City, county, state, and federal regulations and codes in effect as of date of purchase order.

- d. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.

F. Submittals:

1. Drawings:
 - a. The system supplier shall submit engineered drawings, control sequences, bill of materials, bus riser diagrams, hardware/software product data sheets, and applicable valve and damper schedules for approval.
 - b. Drawings shall be submitted in the following standard sizes: 11" x 17" or 8 1/2" x 11"
 - c. Six complete sets of submittal drawings shall be provided.
 - d. Drawings shall be available on CD-ROM.
2. Installer Qualifications:
 - a. The system supplier shall provide a list of all personnel certified by the manufacturer to install the control system. The list shall include name, phone number, level of certification and date of certification.
3. Operation and Maintenance Manuals:

Manuals will be provided prior to final acceptance and shall include:

 - a. Installation instructions.
 - b. Principles of operation and a detailed system description.
 - c. Startup and operating instructions.
 - d. System layout and interconnection schematic diagrams.
 - e. Routine preventive maintenance procedures and corrective diagnostic troubleshooting procedures.
 - f. Name, address and telephone number of the DDC Systems field representative.
 - g. Complete recommended spare parts list.

G. Scheduling and Coordination:

1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software configuration phases.
2. The schedule shall show all the target dates for transmission of project information and documents and shall indicate timing and dates for system installation, debugging, and commissioning.

H. Warranty:

1. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion and acceptance by the owner, except for damages from other causes.
2. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours during normal business hours.

3. This warranty shall apply equally to both hardware and software and be at no cost to the owner.

I. Manufacture:

1. The installer shall only use products from the following list of acceptable manufacturers:
 - a. Carrier Corporation: i-Vu Building Automation by American Chiller of Boise.
2. Owner reserves the right to reject, at their option, any and all bids that do not meet the specified requirements stated.

PART 2 – PRODUCTS

2.1 HARDWARE

A. Energy Management PC:

1. BMS Client PC
 - a. Operator Client Interface
Each standard browser connected to the server shall be able to access all system information.
 - b. Hardware
Each client computer shall consist of the following:
Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. Provide Dual core processor, 1.5 GB RAM, 10Mbps or higher LAN communications, serial, parallel, cables as required for proper DDC system operation. The client PC shall support a minimum screen resolution of 1024 x 768 32-bit color.
 - c. Browser Software
Client computer shall have an industry-standard professional-grade operating system. Operating system shall support Google™ Chrome™, Internet Explorer, Mozilla Firefox, and Safari web browsers with Java and ActiveX plugins enabled.
 - d. Communication
Each client shall be able to communicate to the server over a Local Area Network (LAN) or Wide Area Network (WAN) using industry standard Internet Protocols.
2. BMS Server PC
 - a. Operator Interface: Server
 - 1) Web server shall reside on the existing high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information. The Operator Workstation or server shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L.
 - b. Operating Software
 - 1) Web server or workstation shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the DDC System manufacturer's minimum requirements for their software. Typically acceptable systems include Microsoft Windows7, Microsoft Vista, Microsoft Windows XP Pro, Windows Server 2003 or 2008.

- c. Communication
 - 1) Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.
 - d. Portable Operator's Terminal
 - 1) Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.
- B. Field Installed Controller (Fic)
- 1. Controllers, General Purpose Open
 - a. Advanced Application Controllers (AAC) shall be a solid state micro-controller with configurable control module with pre-tested and factory configured software specifically designed for regulating building equipment using closed-loop Direct Digital Control and facility management routines. Controllers shall be capable operating in a stand-alone or networked manner, and shall be located where shown on the plans. The controller shall be powered from standard, off-the-shelf, Class II, 24-volt transformers. The controller shall be easily mounted in a standard NEMA 1 type enclosure without special rails or mounting hardware and as local and national code dictates. The controller shall be capable of operating in either a stand-alone mode or as part of a network with an EMS operator's station and other system elements including Product Integrated Controllers (PIC's)
 - b. BACnet. Advanced Application Controllers (AACs). AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing. AAC shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
 - c. Custom Programming:
The controller shall contain a graphical controller based programming language for creating complex control strategies for specific unique applications. Custom programs shall be retained in controller memory and shall not require a host CPU to operate. All custom programming point data shall be transferable from one controller to another (if networked) directly without an on-line CPU or host computer.
 - d. Communication.
 - 1) Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
 - 2) Data Sharing. Each AAC shall share data as required with each networked.
 - e. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - 1) Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 - 2) Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

- f. Memory.
 - 1) The Controller shall have a Non-Volatile Memory providing indefinite storage of application and configuration data.
 - 2) Controller memory shall support operating system, database, and programming requirements.
- g. Controller Time.
 - 1) Controller shall feature and maintain a 365-day Real-Time Clock/Calendar with holiday functions.
- h. Standalone capability. The controller shall be capable of providing all control functions of the HVAC system without the use of a computer.
 - 1) It shall establish occupancy scheduling based on its own local occupancy schedule, the closure of a contact connected to an external time clock or EMS system, or by a timed override request (1 to 24 hours) through its space temperature sensor override button.
- i. Networked capability. The controller shall include the inherent capability to access the system control selections as well as to monitor system performance by means of a communicating network with a PC and EMS software program.
 - 1) When networked, occupancy may be established by user interface or occupancy signal from other controller located in network.
- j. Scheduling. AAC shall provide the following schedule options as a minimum:
 - 1) Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - 2) Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
 - 3) Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
- k. Serviceability.
 - 1) Controller shall have diagnostic LEDs for power, communication, and processor.
 - 2) Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
- l. Immunity to Power and Noise. AAC shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- m. Input and output devices shall be wired to “quick-connect plug type” terminals to facilitate removal of the module without disconnecting wiring from the plug type terminal.
- n. Alarm Processing. The controller shall contain a routine to process alarms. Alarm processing logic shall also monitor return to normal conditions as part of the alarm scan. The operator will have the ability to modify the alarm/alert priority level.
- o. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

- p. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of preconfigured minimum on-time and off-time settings, customized for the specific requirements of the application.
- q. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.
- r. Inputs. Shall support the following input types as a minimum
 - 1) Dry or pulsed dry contacts
 - 2) 0-5 VDC
 - 3) 0-10 VDC
 - 4) 4-20 mA
 - 5) 10K thermistors
 - 6) 1000-ohm Nickel RTD
- s. Outputs. Shall support the following input types as a minimum
 - 1) Discrete types
 - 2) 0-10 VDC analog type
 - 3) 4-20 mA analog type
- t. Real-Time Clock. Shall feature and maintain a 365-day hardware clock/calendar with holiday functions.
- u. Library of direct digital control routines. The following types of factory tested direct digital control routines shall be provided as a minimum:
 - 1) Indoor/Outdoor Lighting Control
 - 2) Time Schedule with/without override
 - 3) Enthalpy/Analog Comparison
 - 4) Analog Comparison
 - 5) Interlock / Permissive Interlock
 - 6) Fan Control
 - 7) Time Schedule with/without override
 - 8) Unit Heater
 - 9) Constant Volume Air Source control with Demand Controlled Ventilation
 - 10) VAV Air Source control with Demand Controlled Ventilation
 - 11) WSHP Loop Monitor and Pump Control
 - 12) WSHP Loop Cooling – Closed Circuit Tower
 - 13) WSHP Loop Cooling – Open Circuit Tower
 - 14) WSHP Loop Heating
 - 15) Electric Meter with Demand Limit

C. Communication Wire:

- 1. Communication Wire
 - a. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
 - b. Install new wiring and network devices as required to provide a complete and workable control network. Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 16. All insulated wire to be stranded copper conductors and UL labeled for 90C minimum service.
 - c. Physically, bus extender devices (Repeaters) may be utilized to extend the MS/TP bus in length and number of networked controllers. Each Repeater shall be able to regenerate and transmit bi-directional signals and support communications for the

added bus segment. The repeater shall be equipped with LED lights to indicate communications through its RS-485 port

- d. Use existing Ethernet backbone for network segments marked "existing" on project drawings.
- e. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- f. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1) An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, and status shall be viewable and editable from each internetwork controller.
 - 2) Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- g. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.

D. Local Operators Interface

1. Portable Operators Interface

a. Portable Keypad

At least one Keypad with display shall be provided and shall be capable of connecting to any field controller.

Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not provide a keypad and display, provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

2. Touch Screen Operators Equipment Interface Field Mounted

a. Touch Screen, Field Mounted:

An Equipment Touch Screen display shall be provided where indicated. The touch screen shall be capable of acting as a zone sensor, local user interface, and technician tool.

b. Hardware Features:

The touch screen shall feature an illuminated, 4.3" color pixel touchscreen display and shall connect to a single system compatible Open (BACnet®) equipment controller to show the comfort and operating conditions for the connected equipment. Designed for wall mounting, up to 500 feet from controller, it shall include a built-in temperature and humidity sensor suitable for single-zone rooftop applications.

c. Software Features:

The touch screen shall include multi-level password protection for security and shall provide building occupants, facility managers, and technicians a powerful

user interface for managing the connected equipment. Building occupants shall easily adjust setpoints and initiate timed local overrides, while facility managers can monitor detailed operating conditions and also configure equipment schedules, trends, and alarms. Technicians have the added benefit of using the touch screen as a technician tool, enabling them to start-up, commission, and troubleshoot the connected equipment. The touch screen shall view or change its property values, schedule equipment, view trends and alarms, and more, without having to access the system's server.

3. Touch Screen Operators System Interface Field Mounted

a. Touch Screen, Field Mounted for System use:

A touch screen display shall be provided where indicated for system use. A System Touch Display shall be an integrated component of the Building Automation System. It shall feature an illuminated, 4.3" color pixel touchscreen display and shall connect directly to a network of Open (BACnet MS/TP), controllers. Designed for wall mounting, it shall provide building occupants, facility managers, and installers a user interface for managing all of the equipment in a building.

b. Hardware Features:

The touch screen shall feature an illuminated, 4.3" color pixel touchscreen display and shall connect to the building automations system BACnet MS/TP network. The controller shall show the comfort and operating conditions for the connected equipment. Designed for wall mounting, and connected to an MS/TP BACnet buss up to 2000 feet in length. It shall include a built-in temperature and humidity sensor suitable for single-zone rooftop applications, if needed.

c. Software Features:

The touch screen shall include multi-level password protection for security and shall provide building occupants, facility managers, and technicians a user interface for managing the connected equipment. Building occupants shall easily adjust setpoints and initiate timed local overrides, while facility managers can monitor detailed operating conditions and also configure equipment schedules, trends, and alarms. Technicians shall have the benefit of using the touch screen as a technician tool, enabling them to start-up, commission, and troubleshoot the connected equipment. The touch screen shall view or change its property values, schedule equipment, view trends and alarms, and more, without having to access the system's server. The touch screen shall offer audible and visual indicators for all alarms in the system, with the capability to view, acknowledge, and delete system alarms from a single screen.

E. Field Sensors

1. Common Field Sensors

a. Space Temperature Sensors

Space Temperature Sensors shall be 10,000-ohm thermistors or resistance temperature detector types with wall plate adapter and blank cover assembly. If so indicated on the plans, the sensor shall include an integral occupancy override button, an RJ11 communications port, and optional space temperature adjustment slide.

b. Communicating Space Temperature Sensors

Communicating Space Temperature Sensors shall be powered by 24 Vac, wall mounted, and control the room's HVAC (heating, cooling, and ventilation) equipment through RS-485 bus communications. The sensing element shall be a

10,000-ohm thermistor and enclosed in a plastic housing. Sensors shall be equipped with a liquid crystal display (LCD) with 4 push-button user interface for configuring setpoints and time schedules. Sensors shall store configuration parameters in non-volatile memory and provide coordinated control of the HVAC equipment after a power outage.

c. Duct Temperature Sensors

Duct Temperature Sensors shall be 1000-ohm single point or averaging type as need. Averaging sensors shall be RTDs, or 10,000-ohm averaging thermistors. Single point sensors shall be 5,000 ohm or 10,000-ohm thermistors.

d. Outside Air Sensors

Outside Air Sensor shall 10,000-ohm thermistor, with integral PVC housing and 1/2" NPT conduit connector.

e. Water Temperature Sensors

Water Temperature Sensors shall be well mounted or pipe-clamp types as specified on the plans. Sensors shall be 10,000-ohm thermistors, or 1,000-ohm RTDs. Locate as shown on the plans, and provide extended neck wells where applicable on insulated pipes.

Changeover thermostats shall be 10,000-ohm strap on thermistors with flexible copper plate and screw clamp for externally mounting on the pipe.

f. Space CO2 Sensor with Temperature Sensors

The wall mounted combination sensors shall contain a space temperature sensor and Carbon Dioxide (CO2) sensor in a single. The CO2 sensor shall use single-beam absorption infrared diffusion technology and be self-calibrating. The CO2 range shall be 0-2000 PPM with analog outputs of 4-20 ma or 0-10 v. with a power source of 18-30 Vac, 50/60 Hz. The accuracy shall be +/- 100 PPM at 60F to 90F. The sensor shall include an integral occupancy override button, a set point adjustment slidebar, and an RJ14 communication port.

g. Space and Duct CO2 Sensors

The wall mounted, hand held, or duct mounted sensors shall utilize single-beam absorption infrared diffusion technology, and be self-calibrating. The CO2 range shall be 0-2000 PPM with analog outputs of 4-20 ma or 0-10 v. with a power source of 18-30 Vac, 50/60 Hz. The accuracy shall be +/- 100 PPM at 60F to 90F.

h. Transmitters

1) Pressure Transmitters

Transmitters shall provide accessible zero and span adjustments, and shall measure gauge or differential pressure of liquids or gases over several operating scales extending from 30 inches vacuum to 2000-psig. The Transmitter shall vary the output current in proportion to the input pressure, and shall operate with a nominal supply voltage of 12 to 32 V dc as needed and provide a 4-20 mA output signal.

2) Flow Transmitters

Transmitters shall be powered by 24 Vdc, and provide a digital display of gpm and totalized flow. Transmitters shall convert a digital flow signal into a 4-20 mA output signal for flow rate indication, and divide the digital input signal into a selectable digital dry or electronic contact pulse output signal for flow totalization indication. Transmitters shall provide excitation voltage for flow sensors and an LED indication of pulse activity.

i. Current to Pressure Transducers

Current to Pressure Transducers shall convert the 4 to 20ma or 0 to 10 Vdc analog output signal from the controller into a 3-15 PSI pneumatic output. It shall contain a 0-30 PSI manifold gauge indicating actual output air pressure.

- j. Flow Sensors
Flow Sensors shall utilize differential pressure or a vane to measure water flow and have an operating range with an adjustable setpoint as needed. Water flow types shall be complete with safety shut-off valves and all necessary connections. Flow sensors shall generate a 4-20ma or 0-10Vdc proportional signal as needed.
 - k. Status Indication
A current sensing or differential pressure device shall provide status indication for fans and pumps.
The current sensing device shall be installed at the motor starter or motor to provide load indication. The device shall consist of a current transformer, a solid state current sensing circuit with adjustable trip point, and a solid state or contact switch. A red light emitting diode (LED) shall indicate the ON OFF status of the unit. The switch shall provide a N.O. contact for wiring back to the General Purpose Controller.
A differential pressure sensing device shall be installed across the fan or pump and utilize two sensing elements to provide pressure indication. The device shall operate a SPDT switch with adjustable trip point contact for wiring back to the General Purpose Controller.
 - l. Filter / Status Switches
Filter Switch shall be a differential pressure type, adjustable across the range of the device, with a single pole double throw switch. The range, in inches water column, shall be as indicated on the plans.
 - m. Float Switches
Float Switches shall be equipped with a stainless steel float, magnetically actuated, and capable of sensing fluids with a specific gravity of 0.7 and higher.
 - n. High Temperature Detection Thermostats
High Temperature Detection Thermostats shall be of the manual reset type with sensing element arranged to insert into duct or casing and shall be set for 165F. The device shall have double pole, NO, NC contacts for supply fan shutdown and remote alarming.
 - o. Low Temperature Detection Thermostats
Low Temperature Detection Thermostats shall be of the manual reset, type unless otherwise specified, with sensing element not less than 20 feet long. The device shall have double pole, NO, NC contacts for supply fan shutdown and remote alarming. If alarming is not required, the device shall have a single pole, NC contact.
 - p. Start/Stop and Status Relays
Start/Stop and Status Relays shall be designed to plug into a screw terminal-mounting socket. Relays shall be single pole, or double pole as required with double throw contacts rated for required duty. Magnetic Latching Type Control Relay coils shall be activated by a pulsed input and shall maintain condition even during a power failure. A built-in indicator shall show set/reset condition.
 - q. Power Supplies and Transformers
Power Supplies and Voltage Transformers shall convert 120 Vac primary supply voltage into 24 Vac or 24 Vdc control voltage as needed.
- 2. Common Field Sensors: Additional
 - a. Occupancy Sensors
Occupancy Sensors shall be 24 Vdc, have LED status indication, ceiling or wall mounted, and utilize passive Infrared (PIR) technology. Sensors shall utilize

adjustable sensitivity and time-delays to activate an isolated SPDT relay to shut off lights or equipment.

- b. Voltage to Current Converters
Voltage to Current Converters shall be 24 Vdc and convert a 1-19 Vdc direct or reverse acting input signal into a 4-20 mA output signal. Converters shall provide 6 or 10Vdc output reference voltages to power input devices and provide LED signal indication.
- c. Flow Measuring Stations
Airflow Measuring Stations shall utilize an array of total and static pressure tubes and measure differential pressure as indicated on the plans. Station shall establish average readings of total and static pressure values.
- d. Selector Switches
Selector switches shall be general purpose for pilot duty, provide screw terminal connectors, and may be toggle on-off, push button on-off, auto-off, or hand-auto-off, as needed. Switch poles and throw shall be as shown on the plans.
- e. Sequencers
Sequencers shall be 24 Vac/Vdc, and provide from 1 to 6 stages of SPDT relay output control from a single 0.75 to 15 Vdc or 0.5 to 20mA input signal. Each relay shall have an adjustable coil pull-in on a rise or fall in input signal and have LED indication of status.
- f. Setpoint Controllers
Set Point Controllers shall be 24 Vac/Vdc and provide proportional - integral (PI) control for a wide variety of applications. The controllers shall be direct or reverse acting and accept an input signal of 4-20 mA, 1-5 Vdc, or a temperature thermistor. Controllers shall provide a 4-20 mA output signal, and have an adjustable setpoint, throttling range, and reset rate.
- g. Pulse Meter
Pulse meters shall be obtained from the local utility company for the purpose of measuring building KW usage. The utility company shall define the conversion rate/pulse and the recommended sampling time to be used in converting the meter pulses into KWH values.
- h. Alarm Indication Devices
Remote Alarm Indication Devices shall provide visual (Red Alarm LED) and audible (horn) indication, and have an optional push button test/reset switch as required.

3. Communicating Space Sensors

- a. Communicating Space Sensors
Communicating Space Temperature Sensors shall be powered by 12 VDC, wall mounted, and control the room's HVAC (heating, cooling, and ventilation) equipment through RS-485 bus communications. The sensing element shall be enclosed in a plastic housing and shall be a 10,000-ohm thermistor with a range of -4° to 122° F (-20° C to 50° C) and accuracy: $\pm 0.35^{\circ}$ F (0.2° C). All communicating sensors shall have a hidden communication port to allow a handheld service tool access to the controller network.
 - 1) Where indicated on the plans, provide Plus style sensors which shall be equipped with a sliding setpoint adjustment, an occupancy indicating LED and an override pushbutton.
 - 2) Where indicated on the plans, provide Pro style sensors which shall be equipped with a liquid crystal display (LCD) with 4 push-button user interface for configuring setpoints and time schedules. Sensors shall store

configuration parameters in non-volatile memory and provide coordinated control of the HVAC equipment after a power outage.

In addition to sensing temperature, communicating sensors shall have the following combinations of sensing capabilities:

- a) Combination Space Temperature / RH Wall Sensors
Temp Range of 50° F to 104° F (10° C to 40° C) Accuracy: $\pm 0.5^{\circ}$ F (0.3° C).
Relative Humidity Range: 10% to 90% Accuracy: $\pm 1.8\%$ typical
- b) Combination Space Temperature / CO2 Wall Sensors
Temp Range of 50° F to 104° F (10° C to 40° C) Accuracy: $\pm 0.5^{\circ}$ F (0.3° C)
CO2 Range/Accuracy: 400 to 1250 PPM = ± 30 PPM or 3% of reading, whichever is greater. 1250 to 2000 PPM = $\pm 5\%$ of reading plus 30 PPM
- c) Combination Space Temperature / VOC Wall Sensors
Temp Range of 50° F to 104° F (10° C to 40° C) Accuracy: $\pm 0.5^{\circ}$ F (0.3° C)
VOC Range: 0 to 2,000 PPM Accuracy: ± 100 PPM
- d) Combination Space Temperature / RH / CO2 Wall Sensors
Temp Range of 50° F to 104° F (10° C to 40° C) Accuracy: $\pm 0.5^{\circ}$ F (0.3° C) Relative Humidity Range: 10% to 90% Accuracy: $\pm 1.8\%$ typical
CO2 Range/Accuracy: 400 to 1250 PPM = ± 30 PPM or 3% of reading, whichever is greater. 1250 to 2000 PPM = $\pm 5\%$ of reading plus 30 PPM
- e) Combination Space Temperature / RH / VOC Wall Sensors
Temp Range of 50° F to 104° F (10° C to 40° C) Accuracy: $\pm 0.5^{\circ}$ F (0.3° C)
Relative Humidity Range: 10% to 90% Accuracy: $\pm 1.8\%$ typical
VOC Range: 0 to 2,000 PPM Accuracy: ± 100 PPM

In areas when multiple space conditions are to be measured / controlled, all combinations of sensors shall be provided in one sensor housing and shall be installed on a standard 4" x 2" junction box. Any deviation from this requires written approval from the engineer and architect.

F. Controlled Devices

1. Dampers / Valves / Actuators

a. Motorized Control Dampers

Unless specified elsewhere, shall be as follows:

- 1) Multiple blade dampers shall be parallel or opposed blade type as listed below or as scheduled on the drawings.
- 2) Single blade round dampers shall have an elliptical blade.
- 3) Modulating outdoor air and exhaust dampers shall be opposed blade type with blade and side seals.
- 4) Modulating return air dampers shall be parallel blade type with blade and side seals.
- 5) Two position shut off dampers may be parallel or opposed blade type with blade and side seals.

- 6) Damper frames shall be 16 gauge galvanized steel channel or 1/8" extruded aluminum with reinforced corner bracing.
 - 7) Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (<2000 fpm). Blades shall not be less than 16 gauge.
 - 8) Damper shaft bearings shall be as recommended by manufacturer for the application, Oilite or better.
 - 9) All blade edges and top and bottom of the frames shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. The blade seals shall provide for a maximum leakage rate of 10 cfm/sq. ft. at 4" w.c. differential pressure.
 - 10) Individual damper sections shall not be larger than 48" wide x 60" high. Provide a minimum of one damper actuator per section.
 - 11) Dampers shall have exposed linkages.
- b. Electronic Valve and Damper Actuators
Unless specified elsewhere, shall be as follows:
- 1) Electronic actuators, less than 600 in-lb. of rated torque, shall have ISO Electronic 9001 quality certification and be UL listed under standard 873, CSA C22.2 No. 24 and have CE certification.
 - 2) Electronic actuators used on valves or dampers shall be designed to directly couple and mount to a stem, shaft or ISO style-mounting pad. Actuator mounting clamps shall be a V-bolt with a toothed V-clamp creating a cold weld, positive grip effect. Single point, bolt, or single screw actuator type fastening techniques or direct-coupled actuators requiring field assembly of the universal clamp is not acceptable.
 - 3) Actuators shall be fully modulating/proportional, pulse width, floating/tri-state, or two-position as required and be factory or field selectable. Actuators shall have visual position indicators and shall operate in sequence with other devices if required.
 - 4) Optional auxiliary switches shall be available.
 - 5) Actuators shall have an operating range of -22° to 122°F.
 - 6) Proportional actuators shall accept a 0-10 VDC or 0-20 mA input signal and provide a 2-10 VDC or 4-20 mA (with a load resistor) operating range.
 - 7) Actuators shall be capable of operating on 24, 120 or 230VAC, or 24VDC and Class 2 wiring as dictated by the application. Power consumption shall not exceed 50 VA for AC, including 120VAC actuators.
 - 8) Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation.
 - 9) For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Spring return actuators shall be capable of CW or CCW mounting orientation. Spring return models > 60 in-lbs. will be capable of mounting on shafts up to 1.05" in diameter. Spring return actuators with more than 60 in-lb. of torque shall have a metal, manual override crank.
 - 10) Upon loss of control signal, a proportional actuator shall fail open or closed based on the minimum control signal. Upon loss of power, a non-spring return actuator shall maintain the last position.
 - 11) Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required. Valves and dampers requiring greater torque or higher close off may be assembled with multiple low torque actuators.

- 12) Dual mounted actuators using additional anti-rotation strap mechanical linkages, or special factory wiring to function are not acceptable. Actuators in a tandem pair must be "off the shelf," standard actuators ready for field wiring.
 - 13) Damper and valve actuators will not produce more than 62 dB when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise rating of 45 dB(A) with power on or in the running or driving mode.
2. Variable Freq. Drive
 - a. Variable Frequency Drive (VFD)
 - 1) The VFD shall be the AC adjustable frequency type for HVAC applications. Drive shall be factory programmed for variable torque applications, and for the specified motor and application voltage. Drive shall be ISO 9001 certified, and UL listed and CSA approved (up to 125 hp).
 - 2) Drive Environmental Conditions:
The VFD shall be housed indoors in a NEMA 1 metal enclosure and subjected to an non-condensing (95% RH maximum) ambient environment between -14 to 104F.
 - 3) Control System:
The variable speed drive shall include the following features:
 - a) Full digital control.
 - b) Insulated Gate Bi-Polar Transistors (IGBT) used to produce the output pulse width modulated (PWM) waveform, allowing for quiet motor operation.
 - c) Inverters capable of operation at a frequency of 8 kHz so no acoustic noise shall be produced by the motor.
 - d) Digital display keypad module, mounted on the VFD enclosure.
 - e) Local/Remote and Manual/Auto function keys on the keypad.
 - f) UL-listed electronic overload protection.
 - g) Critical frequency avoidance.
 - h) Self diagnostics.
 - i) On-board storage of unit manufacturer's customer user settings, retrievable from the keypad.
 - j) RS232C communications capability standard.
 - k) RS485 communications capability (accessory card source required).
 - l) Internal electronic filtration to reduce EMI generation.
 - 4) VFD Remote Display Service Module:
Accessory package shall contain VFD adapter plate, remote display housing (to accept the keypad module removed from the VFD housing) and cable assembly with quick-connect plug to connect to mating plug on VFD adapter plate, to facilitate VFD diagnostics and servicing.

G. Application Specific Controllers:

1. Equipment Applications
 - a. Fan Coil Controllers
 - 1) Fan Coil Retrofit Controller (FRC)
Defined as BACnet Application Specific Controllers (ASC) shall utilize a solid-state microprocessor based controller and specifically designed closed loop Direct Digital Control (DDC) algorithms to control a room fan coil

terminal in a stand-alone or networked manner. The FRC shall be fully factory tested, and mounted at the unit or where shown on the plans. All control transformers shall be field supplied, mounted and wired. The FRC shall not require a battery. All configuration data is to be stored in non-volatile memory. Systems that require a battery to store data are not acceptable.

- a) The FRC shall include the following factory-supplied and field-installed and wired (unless noted otherwise below) control hardware:
 - Supply Air Sensor: 10,000-ohm thermistor.
 - Space Temperature as described in section 2.8.D.1, in addition the sensor shall be able to adjust Fan Speed & allow for Mode Selection.
 - DX and Fan Speed Relays: *Field-supplied* relays for fan speed and DX staging control.
- b) Optional Control Hardware:
The FRC shall include the following factory-supplied and field-installed and wired (unless noted otherwise below) control hardware
 - Space Relative Humidity Sensors: (Accuracy of $\pm 3\%$ over a range of 10–90%)
 - IAQ Sensor: The self-calibrating CO₂ sensor shall utilize infrared-diffusion sampling, and be capable of producing a proportional 0 – 10 VDC control signal over a range of 0 – 2000 ppm and shall include indicating LEDs.
 - Two Pipe Changeover Sensor: Strap-on sensor(s) shall be a thermistor
 - Condensate Drain Pan Sensor: Monitors a *field-supplied* and installed condensate level sensor, or the status of the condensate pump.
- c) Control Algorithms
Each FRC shall provide the following control routines through factory resident software:
 - Fan Speed Control: Automatically vary fan speed to meet zone setpoints, or manually set by thermostat fan speed selector switch (“LO,” “MED” or “HI,”)
 - Temperature Compensated Start: Daily start time based on building daily needs and thermal inertia.
 - Changeover Control (Two Pipe ONLY): FRC automatically determines system mode based on supply header water temperature.
 - Hot Water 2-position valve heating control: Cycle valve to maintain zone setpoint.
 - Hot Water modulating valve heating control: Modulate valve to maintain zone setpoint.
 - Electric heat control: Cycle heat stages to maintain zone setpoint.
 - Reheat control: Maintain zone temperature during dehumidification overcooling
 - Chilled water 2-position valve cooling control: Cycle valve to maintain zone setpoint
 - Chilled water modulating valve cooling control: Modulate valve to maintain zone setpoint.

- Dehumidification control: Override zone cooling setpoints to meet zone humidity setpoint
- DX cooling control: Cycle cool stages to maintain zone setpoint.
- Two-position outside air damper control: Provide zone minimum ventilation needs.
- Support IAQ control (Demand Controlled Ventilation CO2 management as per ASHRAE 62) with optional comfort override
- d) Alarm/Alert Processing
The FRC shall contain routine(s) with time delays to process alarms and alerts. All alarms/alerts shall be displayed at a portable PC and via the network at an EMS operator's station or alarm printer.
- b. Rooftop Controllers - Open-Bacnet:
 - 1) Rooftop Unit Controller (RTC) shall control all associated HVAC Constant Volume rooftop equipment functions, and be capable of stand-alone or networked operation. The resident algorithms shall use error reduction logic as designated in ASHRAE standard 90.1 to provide temperature control and energy usage.
 - 2) RTC must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified.
 - 3) BACnet. RTC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing. RTC shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
 - 4) Communication.
 - a) Service Port. RTC shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
 - 5) Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - a) RTC shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 - 6) Memory.
 - a) The Controller shall have a Non-Volatile Memory providing indefinite storage of application and configuration data.
 - b) Controller memory shall support operating system, database, and programming requirements.
 - 7) Controller Time.
 - a) Controller shall feature and maintain a 365-day Real-Time Clock / Calendar with holiday functions.
 - 8) Standalone capability. The controller shall be capable of providing all control functions of the HVAC system without the use of a computer.
 - a) It shall establish occupancy scheduling based on its own local occupancy schedule, the closure of a contact connected to an external time clock or EMS system, or by a timed override request (1 to 24 hours) through its space temperature sensor override button.
 - b) Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

- 9) Networked capability. RTC The controllers shall include the inherent capability to access the system control selections as well as to monitor system performance by means of a communicating network with a PC and EMS software program.
 - a) When networked, RTC occupancy may be established by user interface or occupancy signal from other controller located in network.
- 10) Scheduling. RTC shall provide the following schedule options as a minimum:
 - a) Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - b) Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
 - c) Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
- 11) Serviceability.
 - a) Controller shall have diagnostic LEDs for power, communication, and processor.
 - b) Controller in the system shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
- 12) Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- 13) Hand held or wall mounted local interface device that allow configuration access shall be password protected with minimum of two levels of security. Level one shall provide limited access to controller operational parameters and level two shall provide full access to controller operational and configuration parameters.
- 14) Alarm Processing. The controller shall contain a routine to process alarms. Alarm processing logic shall also monitor return to normal conditions as part of the alarm scan. The operator will have the ability to modify the alarm/alert priority level.
- 15) Demand Limiting. Upon receiving network signal the controller shall be capable of providing separate heating and cooling demand control utilizing two independent demand inputs.
- 16) Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of preconfigured minimum on-time and off-time settings, customized for the specific requirements of the application.
- 17) On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.
- 18) Keypad. Where specified provide a local keypad and display for each ASC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC

- and ASC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.
- 19) Capacity control shall be based on the use of a conventional thermostat, or programmable thermostat, or alternatively, a constant volume unit may utilize its own internal time clock and setpoints (cooling and heating) coupled with a room sensor for capacity control. The controls shall provide separate occupied and unoccupied cooling and heating setpoints – except if a conventional thermostat is used.
 - 20) To maintain zone temperature at setpoint RTC shall utilize:
 - a) fan control
 - b) Up to 2 stages of cooling
 - c) Up to 3 stages of heating
 - 21) Economizer control. RTC shall provide analog output signal for economizer control.

2.2 SOFTWARE

A. Operator Interface

1. Operator Interface

- a. Description. The control system shall be as shown and consist of a high-speed, peer-to-peer network of DDC controllers and a standalone web server operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface. Operators with sufficient access level shall have an ability to make changes to all system and equipment graphics in the web server in addition to having full DDC system access to make configuration changes to the control system. Any tools required for making graphic changes shall be provided with web server.
- b. Operator Interface. Furnish one Web server interface as shown on the system drawings. Operators shall be able to access all necessary operational information in the DDC system via client computer utilizing web browser.
 - 1) Web server shall connect via the LAN and be able to simultaneously serve up controller information to multiple operators connected via LAN with web browsers. Each client web browser connected to server shall be able to access all system information.
 - 2) With the use of a remote SMTP email server the operators interface web server shall be able to notify personnel of an alarm or record information about an alarm in the DDC system.
 - 3) Secondary interface, in addition to the primary operator interface, the system shall include a secondary interface compatible with a locally available commercial wireless network and viewable on a commercially available wireless device such as a Wireless Access Protocol (WAP) enabled cellular telephone and tablet devices. As a minimum, the following capabilities shall be provided through this interface:
 - a) Secondary interface with screen resolution 1024x768 and above shall be able to provide a full graphical environment as the primary interface.

- b) Secondary interface with screen resolution lower than 1024x768 may be text-based and shall provide a summary of the most important data. As a minimum, the following capabilities shall be provided through this interface:
 - An operator authentication system that requires an operator to log in before viewing or editing any data, and which can be configured to limit the privileges of an individual operator.
 - The ability to view and acknowledge any alarm in the system. Alarms or links to alarms shall be provided on a contiguous list so the operator can quickly view all alarms.
 - A summary page or pages for each piece of equipment in the system. This page shall include the current values of all critical I/O points and shall allow the operator to lock binary points on or off and to lock analog points to any value within their range.
 - Navigation links that allow the operator to quickly navigate from the home screen to any piece of equipment in the system, and then return to the home screen. These links may be arranged in a hierarchical fashion, such as navigating from the home screen to a particular building, then to a specific floor in the building, and then to a specific room or piece of equipment.
- c. Web Server Hardware. Furnish one web server with Ethernet port for LAN or direct operator client computer access. The web server shall be capable of communicating to the peer to peer DDC controller network. Any required installation or commissioning software shall be pre-installed on the web server. Installation or commissioning of the web server shall be done through a client computer with a standard web browser.
- d. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.
- e. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
 - 1) Log In and Log Out. System shall require user name and password to log in to operator interface.
 - 2) Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
 - 3) View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as set points, PID gains, on and off controls, and sensor calibration.
 - 4) View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
 - 5) View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms. Remote users shall be able to receive alarms via emails or cell phone text messages.

- 6) View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
 - 7) View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
 - 8) Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
 - 9) Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.
- f. System Software.
- 1) Operating System and required software. Web server operator interface shall be a self-contained web server without the need for any type of maintenance.
 - 2) System Graphics. Operator interface shall be graphical and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
 - a) Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - b) Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - c) Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d) Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).
- g. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard Windows compatible PCs with no limit on the number of copies that can be installed under the system license.
- 1) Automatic System Database Configuration. Each web server shall store internally store a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 - 2) Controller Memory Download. Operators shall be able to download memory from the system database to each controller.

- 3) System Configuration. Operators shall be able to configure the system.
- 4) Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.
- 5) Security. System shall require a user name and password to view, edit, add, or delete data.
 - a) Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.
 - b) Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
 - c) Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
- 6) System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
- 7) Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Points List. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
- 8) Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
- 9) Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
- 10) Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server from each workstation or web browser interface.
- 11) Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Points List. Trends shall be BACnet trend objects.
- 12) Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics.
- 13) Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
- 14) Standard Reports. Furnish the following standard system reports:
 - a) Reports shall be filtered based upon the selected equipment
 - b) Alarm Reports
 - Alarm Summary - Current alarms

- Alarm Sources – List of equipment and associated alarm conditions
- Alarm Actions – Configured alarm actions such as e-mail and alarm pop-up
- c) Schedule Reports
 - Effective Schedules – Displays effective schedules for each equipment
 - Schedule Instances – Displays all schedules entered
- d) Security Reports – Maintains audit of all actions taken through user interface
- e) Commissioning Reports – Provide equipment checkout status and notes
- f) Equipment Reports – Provide reports showing trended points and available network points
- 15) Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
- 16) Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
- 17) Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.
- h. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.
- i. CCN (Carrier Comfort Network) Communication. Web server or workstation shall also support communication using CCN protocol.
- j. Timed override reporting (i-Vu Plus)
 - 1) The DDC system shall track all push button timed override events during unoccupied periods. The system shall store time of the override event and time duration for each override event.
 - 2) Web server shall allow operators to create custom reports detailing timed override events. Timed override reports shall allow the following options:
 - 3) Minimum billing time. A minimum amount of time that each override event will last.
 - 4) Billing rate. A monetary rate per hour or per minute of the override duration.
 - 5) Exemption times. A defined block of time during each week that is exempt from detecting override events.
 - 6) Allowances. A dollar amount of override usage that is allowed per tenant and is given at no charge. This allowance will be subtracted from the tenant's total override usage.
- k. Web services data exchange (i-Vu Plus)

System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the DDC system.

- 1) System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 - 2) System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 - 3) For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
 - 4) System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.
1. Open Protocol Communications (i-Vu Plus)
- DDC system shall allow communication to ancillary systems or controllers, such as lighting system or VFD controllers that utilize BACnet, Modbus, or LonWorks communication protocols. The quantity of data points available per protocol shall be based upon system memory and capacity and will not require the purchase of additional licenses or fees.
- 1) BACnet communication
 - a) DDC System shall support BACnet/IP addressing as specified in ASHRAE/ANSI 135, BACnet Annex J using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol.
 - b) DDC System shall support BACnet MS/TP communications using EIA-485 twisted pair topology running at 9600, 19200, 38400, and 76800 baud.
 - 2) Modbus communication
 - a) DDC System shall support Modbus RTU/ASCII communications over EIA-485/EIA-232 type network at 9600, 19200, 38400, and 76800 baud.
 - b) DDC System shall support Modbus TCP/IP communications over ISO 8802-3 (Ethernet) Data Link/Physical layer protocol.
 - 3) LonWorks communication
 - a) DDC system shall support LonWorks communication utilizing ANSI/EIA-709.1 communications over FT-10A network.
 - b) Communication between devices shall be via Standard Network Variable Types (SNVTs)

PART 3 – EXECUTION

3.1 EXECUTION

A. Examination

1. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.
2. Notify the Owners Representative in writing of conditions detrimental to the proper and timely completion of the work.

B. Installation (General)

1. Install hardware and software in accordance with manufacturer's instructions.
2. Provide all miscellaneous devices, hardware, software, interconnections installation and configuration required to insure a complete operating system in accordance with the sequences of operation and point schedules.
3. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
4. Install equipment, piping, and wiring/raceways parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

C. Location and Installation of Components

1. Locate and install components for easy accessibility; in general, mount 60 inches above floor with minimum 3'-0" clear access space in front of units. Obtain approval on locations from Owner's representative prior to installation.
2. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.
3. Identify all equipment and panels. Provide permanently mounted tags for all panels.
4. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections; sized to suit pipe diameter without restricting flow.

D. Interlocking and Control Wiring

1. Provide all interlock and control wiring. All wiring shall be installed in a neat and professional manner in accordance with Specification Division 16 and all national, state and local electrical codes.
2. Provide wire and wiring techniques recommended by equipment manufacturers.
3. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the Owner's representative prior to rough-in.
4. Provide auxiliary pilot duty relays on motor starters as required for control function.
5. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings; coordinate with electrical contractor.

6. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed in a neat and inconspicuous manner per local code requirements.
7. When a cable enters or exits a building, a surge suppressor must be installed. The surge suppressor shall be installed according to the manufacturer's instructions.
8. All sensor wiring shall be labeled to indicate the origination and destination of data.

E. Field Services

1. Prepare and start the control system under provisions of this section.
2. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
3. Provide the capability for off-site monitoring. As a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide internet connection for this service for 1 year or as specified.
4. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.
5. Provide the Owners Representative an in warranty maintenance proposal.

F. Training

1. Provide training to the owner in the operation of systems and equipment.
2. Provide basic operator training for a minimum of 3 people on all functions of the Operator Interface unit.
3. Provide training, as required, for up to 10 hours as part of this contract.

G. Demonstration

1. Provide systems demonstration of each sub-system.
2. Demonstrate a complete operating system to Owner's Representative.
3. Provide certificate stating that control system has been tested and adjusted for proper operation.

END OF SECTION 23 09 00

SECTION 260500 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Provisions of this Section shall apply to all Sections of Division 26.

1.2 SCOPE OF WORK

- A. Furnish and install all materials and equipment and provide all labor required and necessary to complete the work shown on the drawings and/or specified in all Sections of Division 26 and all other work and miscellaneous items, not specifically mentioned, but reasonably inferred for a complete installation, including all accessories required for testing the system. It is the intent of the drawings and specifications that all systems be complete and ready for operation.

1.3 CODE COMPLIANCE

- A. All work and materials shall comply with the latest rules, codes and regulations, including, but not limited to, the following:
 - 1. Occupational Safety and Health Act Standards (OSHA)
 - 2. NFPA #70 – National Electric Code (NEC)
 - 3. ADA Standards – Americans with Disabilities Act
 - 4. ANSI/IEEE C-2 – National Electrical Safety Code
 - 5. NECA – Standard of Installation
 - 6. International Building Code
 - 7. International Fire Code
 - 8. International Energy Conservation Code
 - 9. NFPA #72 – Fire Code
 - 10. NFPA #101 – Life Safety Code
 - 11. All other applicable Federal, State and local laws and regulations.
- B. Work to be executed and inspected in accordance with local codes and ordinances. Permits, fees or charges for inspection or other services shall be paid for by the contractor. Local codes and ordinances are to be considered as minimum requirements and must be properly executed without expense to the owner; but do not relieve the contractor from work shown that exceeds minimum requirements.

1.4 CONDITIONS AT SITE

- A. Visit to site is recommended of all bidders prior to submission of bid. All will be held to have familiarized themselves with all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.
- B. Lines of other service that are damaged as a result of this work shall be promptly repaired at no expense to the owner to the complete satisfaction of the owner.

1.5 DRAWINGS AND SPECIFICATIONS

- A. All drawings and all specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.
- B. Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Most direct routing of conduits and wiring is not assured. Exact requirements shall be governed by architectural, structural and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitting bid.
- C. Change to location, type, function, brand name, finish, etc., shall not be made without permission of engineer.
- D. Some equipment is specifically designated on the drawings. It is not the intent to sole source any item unless explicitly stated. Items have been specified based upon design requirements. All bidders are encouraged to submit products for approval. Prior approval must be obtained as required by these contract documents. Bids submitted with non-approved items will be considered invalid and bidders will be held to provide approved materials at no additional cost to the owner. Submittals received by the engineer after award of contract on non-approved equipment will not be reviewed nor will they be returned.
- E. Where conflicting direction is given within the specifications and drawings, the contractor shall include the most expensive option in the bid.

1.6 SAFETY AND INDEMNITY

- A. Safety: The contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours.
- B. No act, service, drawing review or construction review by the owner is intended to include review of the adequacy of the contractor's safety measures in, on, or near the construction site.

1.7 CONSTRUCTION OBSERVATION BY THE ENGINEER

- A. Prior to covering: any major portion of the materials installed under this section, notify the engineer so that an observation can be made. Notification shall be made at least three (3) working days in advance of the date the items will be covered.

1.8 INSTRUCTION OF OWNER'S PERSONNEL

- A. The contractor shall conduct an on-site instructional tour of the entire project. The personnel designated by the owner shall be instructed in: operation of all electrical systems, trouble-shooting procedures, preventative maintenance procedures, uses of Operation and Maintenance manuals, relamping and cleaning of lighting fixtures and operation of all special systems.
- B. Contractor will include in his bid 8 hours of instruction time to be held at the project location after substantial completion for instruction of owner's personnel. Coordinate time and number of owner personnel to be present and provide schedule to engineer.

1.9 PROJECT COMPLETION

- A. Upon completion of all work and operational checks on all systems, the contractor shall request that a final construction observation be performed.
- B. The engineer shall compile a punch list of items to be completed or corrected. The contractor shall notify the engineer upon completion of the items.

1.10 GUARANTEE

- A. All work under this section shall be guaranteed in writing to be free of defective work, materials, or parts for a period of one (1) year, except lamps which shall be guaranteed for ninety (90) days, after final acceptance of the work under this contract or the period indicated under the Division 1 specifications whichever is longer.
- B. Repair, revision or replacement of any and all defects, failure or inoperativeness shall be done by the contractor at no cost to the owner.

PART 2 - PRODUCTS

2.1 MATERIAL APPROVAL

- A. The design, manufacturer and testing of electrical equipment and materials shall conform to or exceed latest applicable NEMA, IEEE or ANSI standards.
- B. All materials must be new, unless noted otherwise, and UL listed. Materials that are not covered by UL testing standards shall be tested and approved by an independent testing laboratory or a governmental agency, which laboratory shall be acceptable to the owner and code enforcing agency.

2.2 SHOP DRAWINGS AND MATERIALS LIST

- A. Submit shop drawings and materials lists as specified for review. Seven (7) copies, unless noted otherwise under Division 1, of submittals shall be presented to the architect/engineer.

2.3 OPERATION AND MAINTENANCE MANUALS

- A. Submit four (4) sets, unless noted otherwise under Division 1, of the Operation and Maintenance Manuals of all Division 26 equipment to architect/engineer.

2.4 RECORD DRAWINGS

- A. Submit record drawings to owner.

2.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle materials in a manner to prevent damage.
- B. Protect equipment from weather and dampness.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

- A. Only quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.
- B. Provide experienced foreman with a minimum of three years experience working on this type of building placed in charge of this work at all times.

3.2 COORDINATION

- A. Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under trades that require electrical connections. Inform contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.
- B. Verify equipment dimensions and requirements with provisions specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without the authorization of the owner, shall be at contractor's risk and expense.

3.3 MANUFACTURER'S INSTRUCTIONS

- A. All installations are to be made in accordance with manufacturer's recommendations. A copy of such recommendations shall at all times be kept in the job superintendent's office and shall be available to the engineer.
- B. Follow manufacturer's instructions where they cover points not specifically indicated on drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the engineer before starting work.

3.4 QUALITY ASSURANCE

- A. The contractor shall insure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.
- B. Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and special systems.

3.5 CUTTING AND PATCHING

- A. Perform all cutting and fittings required for work of this section in rough construction of the building.
- B. All patching of finished construction of building shall be performed under the sections of specifications covering these materials.
- C. No joists, beams, girders or columns shall be cut by any contractor without obtaining written permission from the architect/engineer.

END OF SECTION 260500

SECTION 260501 – FIELD TEST AND OPERATIONAL CHECK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. 260502 - Short-Circuit-Coordination Study-Arc Flash Hazard Analysis

1.2 SCOPE OF WORK

- A. Ground resistance test.
- B. 600V cable insulation test.
- C. Main and distribution switchboard and panelboard operational check and test.
- D. Generator test.

1.3 GENERAL SCOPE

- A. The contractor shall engage and pay for the services of a recognized independent testing laboratory for the purpose of performing inspections and tests as specified in this Section.
- B. The testing laboratory shall provide all material, equipment, labor and technical supervision to perform such tests and inspections.
- C. These tests shall assure that all electrical equipment is operational within industry and manufacturer's tolerances, is installed in accordance with design specifications, and shall determine the suitability for energization.
- D. The contractor shall schedule the tests and give a minimum of two weeks advance notice to the owner.

1.4 QUALIFICATIONS OF TESTING AGENCY

- A. Testing agency shall be Current Technologies Inc. or approved equal.

1.5 TEST INSTRUMENT TRACEABILITY

- A. The testing agency shall have a calibration program which maintains all applicable test instrumentation within rated accuracy.

- B. Instruments shall be calibrated at the following frequency:
 - 1. Field instruments: Six months maximum
 - 2. Laboratory instruments: 12 months
 - 3. Leased specialty equipment: 12 months (where accuracy is guaranteed by lessor, e.g. Doble)
- C. Dated calibration levels shall be visible on all test equipment.

1.6 FINAL SETTINGS

- A. The contractor shall set the protective devices in accordance with a short-circuit and protective device coordination report.

1.7 TEST REPORT

- A. Submit copies of the test results to the owner. Test results shall be included in the project O &M Manuals.
- B. The test report shall include a project summary, description of equipment tested, description of test, list of test equipment used and calibration date, test results, conclusions and recommendations, appendix (including appropriate test forms), and standards used.
- C. The test report shall be bound and its contents certified.

1.8 FAILURE TO MEET TEST

- A. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported directly to the owner.
- B. Contractor shall replace the defective material or equipment and have test repeated until test proves satisfactory without additional cost to the owner.

PART 2 – PRODUCTS - Not Applicable

PART 3 - EXECUTION

3.1 GROUND RESISTANCE TEST

- A. Building grounding electrode resistance testing shall be accomplished with a ground resistance direct-reading single test meter utilizing the Fall-of-Potential method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the concrete-encased ground electrode to be tested and the two reference electrodes in a straight line spaced fifty (50) feet apart. Drive the two reference electrodes five (5) feet deep.

- B. Test results shall be in writing and shall show temperature, humidity and condition of the soil at the time of the tests. In the case where the ground resistance exceeds five (5) ohms, the owner will issue additional instructions.

3.2 600 VOLT CABLE INSULATION TEST

- A. Megger and record insulation resistances of all 600 volt insulated conductors size 4/0 AWG and larger using a 500 volt megger for one minute. Conduct tests with circuits isolated from source and load.

3.3 MAIN AND DISTRIBUTION SYSTEM SWITCHBOARD AND PANELBOARD OPERATIONAL CHECK AND TEST

- A. Check cleanliness of all interiors and all parts. Remove any excess packaging, shipping bolts, etc. Inspect for shipping damage.
- B. Tighten all points of connection with torque wrench to values recommended by the manufacturer.
- C. Verify proper operating condition of all equipment mechanically and electrically, including, but not limited to:
 - 1. Wiring for all meters and instrumentation.
 - 2. Verify operation of each circuit breaker trip device with an accurately metered timed instrument (by passing 300 percent rated current through each pole).
 - 3. Verify relay operation by introduction of accurately metered currents into both overcurrent and ground fault circuitry at values which will enable accurate determination of the tripping coordination of main and feeder breakers. Provide this test with the tie breaker when provided.
 - 4. Verify short time pick-up and delay, and instantaneous pick-up current. These should conform with manufacturer's published time current characteristic curves.
 - 5. Auxiliary protective devices such as phase failure relays shall be activated to ensure operation.
 - 6. Determine instantaneous pick-up current by primary injection using run-up or pulse method. Clearing time shall be within four (4) cycles.
 - 7. Perform insulation resistance test per NASET specification section 2.
 - 8. Measure the system neutral to ground resistance with neutral disconnect link removed, for ground fault protected systems.
 - 9. Utilizing primary current injection, verify the breaker picks up and trips within the manufacturer's recommendations.
 - 10. If the ground fault relay is external to the breaker or switch, ensure the operation at reduced voltage (60% for AC control and 80% for DC control).
 - 11. Exercise all devices and components ensuring smooth operation.
 - 12. Devices shall be tested upon settings defined by the breaker coordination study for this project.
- D. If any equipment is found defective during operational check, it shall be replaced by the contractor without cost to the owner and tests repeated by the contractor, without cost to the owner, until satisfactory results are obtained.

3.4 GENERATOR TEST

- A. After the installation and initial start-up of the engine generator set is complete, a test shall be performed and logged in the presence of the owner. The contractor shall have the engine generator manufacturer furnish and engineer to operate the engine during the test, to check all details of the installation and to instruct the operators. The engineer will be required for a period of not less than two days for instruction and tests and all costs in connection therewith shall be included in the contractor's bid. The contractor shall furnish all fuel, lubricants, load banks and instruments necessary to conduct the tests and shall connect all devices required to obtain data required below. The resistor load bank shall be connected to the load side of the automatic transfer switch and the contractor shall make any necessary temporary connections to obtain full load for the test.
- B. On site testing shall include all items specified in NFPA-110.
- C. Field test requirements: Data shall be recorded every 15 minutes and at the beginning and end of every separate test and shall include all electrical and temperature information. Testing shall be accomplished in the following sequence:
 - 1. Check all engine and generator mounting bolts. Check alignment of engine generator and realign if not within manufacturer's limits.
 - 2. Test generator and exciter insulation resistance with a megger. Take generator readings at circuit breaker or at leads to switchboards. Record all results in the test report.
 - 3. Perform engine manufacturer's recommended prestarting checks. Include a check of water, fuel, and lube oil levels within the engine.
 - 4. Start engine and make engine manufacturer's after starting checks during a reasonable run-in or warm-up period.
 - 5. Operate engine generator for one hour at 50% of rated load.
 - 6. Operate engine generator for one hour at 75% of rated load.
 - 7. Operate engine generator for two hours at 100% of rated load.
 - 8. Measure sound level to assure that the sound spectrum does not exceed the criteria specified.
 - 9. Increase engine speed by manually overriding the governor. Speed shall be measured by a tachometer. Record speed at which overspeed trip operates.
 - 10. Demonstrate functioning of high temperatures coolant circuit by restricting airflow through the radiator. Record temperatures.
 - 11. Shutdown engine and observe operation of low oil pressure control. Record pressure at which trip operates. Note: If safety conditions of the safety system are not met during any of the preceding three steps, the necessary readjustments shall be made and the step repeated until satisfactory results are obtained.
 - 12. Ensure proper operation of the automatic exercising system by setting system for automatic operation then manually initiating and exercise period of at least 30 minutes.
 - 13. A battery starting test shall be performed with the charger disconnected, consisting of four (4) cranking cycles of 10 seconds "on" and 10 seconds "off." The engine fuel supply shall be shut off to prevent starting.
- D. Checks to be made during on-site testing:
 - 1. Proper operation of all controls.
 - 2. Proper operation of all gauges and instruments throughout operation.
 - 3. Proper operation of all auxiliary and accessory equipment. All valves, including pilot valves and injection pump, shall be checked during the tests to ensure proper operation.

- E. Inspection: Upon completion of the on-site tests, a general inspection shall be made for:
 - 1. Leaks in the engine, piping systems, tank, etc.
 - 2. Excessive blow-by.
 - 3. Any other deficiency which may impair proper operation.
 - 4. Change oil and oil filter and record hour readings.
- F. Acceptance: Final acceptance shall be made when the generator set has successfully completed the on-site test and after all defects in material or operation have been corrected with maintenance manuals and training completed.

END OF SECTION 260501

SECTION 260519 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

- A. Submit shop drawings and product data.

1.4 COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by the owner.

PART 2 - PRODUCTS

2.1 BUILDING WIRES AND CABLES

- A. Conductors: Stranded, copper, 600 volt insulation, type THHN/THWN, THHN/THWN-2, XHHN/XHHW.
- B. Conductors:
 - 1. Solid or stranded for No. 10 and smaller, stranded for No. 8 and larger, copper, 600 volt insulation, type THHN/THWN. Aluminum conductors not allowed unless noted otherwise.
 - 2. Insulation Types: THWN-2 for underground, THWN for wet locations, THHN for dry locations; XHHN/XHHW for GFI branch circuits and feeders fed from GFCI breakers.
- C. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
 - 1. Phase A: Black.
 - 2. Phase B: Red.
 - 3. Phase C: Blue.

4. Neutral: White.
 5. Ground: Green.
 6. Isolated ground: Green with yellow tracer.
- D. Wire connectors and splices: units of size, ampacity rating, material, type and class suitable for service indicated.
- E. Signal and communication circuits:
1. Special cables as indicated on the drawings.
 2. Conductors for general use: stranded copper conductor, #16 AWG minimum, with THWN-2 insulation for underground, THWN for wet locations and THHN insulation for dry locations.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

- A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Use no wire smaller than #12 AWG for power and lighting circuits and no smaller than #18 AWG for control wiring.
- C. The contractor is responsible for upsizing conductor sizes to ensure the maximum voltage drop of any branch circuit does not exceed 3%. For reference, use No. 10 AWG conductor for 20 Amp, 120 volt branch circuits longer than 75 feet.
- D. Place an equal number of conductors for each phase of a circuit in the same raceway or conduit.
- E. Splice only in junction or outlet boxes.
- F. Neatly train or lace wiring inside boxes, equipment, and panelboards.
- G. Make conductor lengths for parallel circuits equal.
- H. Provide a separate neutral conductor for each ungrounded conductor. Ungrounded conductors may share a neutral when all of the following conditions are met:
 1. The ungrounded conductors are connected to a multi-pole breaker or breakers that are clipped together with a UL listed means that provide a common trip.
 2. The ungrounded conductors contained in the same conduit or raceway.
 3. The ungrounded conductors all originate from a separate and unique phase bus in the panel.

3.2 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions, and the "National Electrical Installation Standards" by NECA.
- B. Remove existing wires from raceway before pulling in new wires and cables.
- C. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means; including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables above accessible ceilings; do not rest on ceiling tiles. Do not fasten cables to ceiling support wires. Use cable ties to support cables from structure.

3.3 CONNECTIONS

- A. Conductor Splices: Keep to minimum.
- B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- C. Use splice and tap connectors compatible with conductor material.
- D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.
- E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.
- G. Terminate spare conductors with electrical tape.

3.4 LABELING

- A. Provide Brady wire markers or equivalent on all conductors. All wire shall be labeled in each box and panel with the circuit number and panel identification.

3.5 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage.
- B. Perform continuity testing on all power and equipment branch circuit conductors. Verify proper phasing connections.

BOISE CITY FIRE STATION #8
BOISE, IDAHO

JANUARY, 2016

END OF SECTION 260519

SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Fixed Price Construction Contract and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral at service entrance equipment to concrete encased electrode, metal underground water pipe, and effectively grounded metal frame of building.
- B. Ground each separately-derived system neutral to nearest effectively grounded metal structural frame of building or point of service entrance ground.
- C. Provide communications system grounding conductor to point of service entrance ground.
- D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductors in raceways and cables, receptacle ground connectors, and plumbing systems.

1.4 QUALITY ASSURANCE

- A. Testing: Refer to Section 260501 – Field Test and Operational Check.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Section 260519 - Conductors and Cables.
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation. Where green insulation is not available, on larger sizes, black insulation shall be used and suitably identified with green tape at each junction box or device enclosure.

- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow tracer. Where not available, green and yellow tape at each junction box or device enclosure.
- E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- F. Bare Copper Conductors: Medium hard drawn copper conductor, stranded, sized as shown on the drawings.
- G. Hardware: Bolts, nuts and washers shall be bronze; cadmium plated steel or other non-corrosive material, approved for the purpose.
- H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.2 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- D. Below grade compression fittings: Thomas & Betts, Series 52000, 53000, and 54000 or equivalent.
- E. Use connector and sealant approved for purpose on all below grade clamp or compression type connections.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, 5/8 inch diameter, minimum length 8 feet.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space **1 inch** from wall and support from wall **6 inches** above finished floor, unless otherwise indicated.
- F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least **24 inches** below grade.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NEC Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NEC are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
 1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
- D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways bonded to outlet or equipment, sized per Section 250 of the NEC.
- G. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on grounding bar.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- H. Provide green insulated ground conductor to exterior post light standards.
- I. Provide grounding and bonding at pad-mounted transformer in accordance with Section 261200.

3.3 INSTALLATION

- A. Ground Rods: Where indicated, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
 - 1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, unless otherwise indicated. Make connections without exposing steel or damaging copper coating.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- E. UFER Ground (Concrete-Encased Grounding Electrode): Fabricate according to NEC 250, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 SYSTEM NEUTRAL GROUND

- A. Ground the neutral conductor of each transformer or generator to limit the maximum potential above ground due to normal operating voltage and limit the voltage level due to abnormal conditions.
- B. Ground generators or transformers with secondary voltage 600 volt or less as follows:
 - 1. 3 phase, 4 wire Wye connected: ground neutral point
- C. For transformers 75 kVA or smaller with primary voltage 480 volt or less the primary equipment ground conductor may be used for grounding the secondary neutral provided it is adequately sized in accordance with NEC system ground conductor size.

3.6 EQUIPMENT GROUND

- A. Ground non-current carrying metal parts of electrical equipment enclosures, frames, conductor raceways or cable trays to provide a low impedance path for line-to-ground fault current and to bond all non-current carrying metal parts together. Install a grounding conductor in each raceway system. Equipment grounding conductor shall be electrically and mechanically continuous from the electrical circuit source to the equipment to be grounded. Size grounding conductors per NEC 250 unless otherwise shown on the drawings.
- B. Install metal raceway couplings, fittings, and terminations secure and tight to ensure good grounding continuity. Provide grounding conductor sized per NEC through all raceway and conduit systems.
- C. Lighting fixtures shall be securely connected to equipment grounding conductors. Outdoor lighting standards shall have a factory installed ground lug for terminating the grounding conductor.

- D. Motors shall be connected to equipment ground conductors with a bolted solderless lug connection on the metal frame.

3.7 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Test ground system per Section 260501.

END OF SECTION 260526

SECTION 260529 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 WORK INCLUDED

- A. Conduit and equipment supports.
- B. Fastening hardware.

1.3 RELATED WORK

- A. Division 3 - Concrete Work. Concrete equipment pads.

1.4 COORDINATION

- A. Coordinate size, shape and location of concrete pads with Division 3.

1.5 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Support Channel: Galvanized or painted steel.
- B. Hardware: Corrosion resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors or beam clamps. Do not use spring steel clips and clamps.
- B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- C. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.
- D. Do not use powder-actuated anchors.
- E. Do not drill structural steel members.
- F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- G. In wet locations install free-standing electrical equipment on concrete pads.
- H. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- I. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- J. All supports and attachments shall meet project seismic zone requirements.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RMC: Rigid metal conduit.
- F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.

- B. IMC: ANSI C80.6.
- C. PVC coated Steel Conduit and Fittings: NEMA RN 1; rigid steel conduit with external 40 mil PVC coating and internal two mil urethane coating.
- D. EMT and Fittings: ANSI C80.3. Fittings: Set-screw type.
- E. FMC: Zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. RNC: NEMA TC 2, Schedule 40 PVC. Fittings: NEMA TC 3; match to conduit and material.

2.3 METAL WIREWAYS

- A. Material: Sheet metal sized and shaped as indicated.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Finish: Manufacturer's standard enamel finish.

2.4 OUTLET AND DEVICE BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.

2.5 FLOOR BOXES

- A. Floor Boxes: Cast metal, fully adjustable, rectangular, unless otherwise specified.

2.6 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.7 ENCLOSURES AND CABINETS

- A. Hinged-Cover Enclosures: NEMA 250, Type 1, 3R, or 4, with continuous hinge cover and flush latch, key operable.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

2.8 J-HOOKS

- A. J-hooks: Steel, rated for indoor use in non-corrosive environments. J-hooks shall be rated to support Category 5e cable.
- B. Fittings and Support Bodies: Manufacturer's recommended fittings including side mount flange clips, bottom mount flange clips, beam clamp, rod and flange clip, C & Z purlin clip, and all other components and assemblies to make the system work.
- C. Acceptable Product: Caddy CableCat Hanging System, 1-5/16" and 2" hooks, or approved equal
- D. Acceptable Manufacturer: Erico Fastening Products or approved equal.
- E. J-hook Supports: Manufacturer's recommended fastening devices.

2.9 INNERDUCT

- A. Innerduct: NEMA TC 5. UL Listed, corrugated, specifically designed for optical fiber cable pathways.
- B. Acceptable Manufactures: Arnco, Carlon, Dura-line, and Pyramid.
- C. Composition:
 1. Non-plenum rated: Polyethylene (PE), or High Density Polyethylene (HDPE).
 2. Plenum rated: per manufacturer.
- D. Nominal Size: 1" (inside diameter), minimum.
- E. Pulling Strength: minimum of 600 pounds.
- F. Color: Orange, solid.
- G. Fittings and Innerduct Bodies: Manufacturer's recommended fittings including couplings, adapters, end caps, end bells, expansion couplings, plugs, sleeves, a full compliment of connective devices, and all other components to make the system work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

- A. Outdoors: Use the following wiring methods:

1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.
3. Underground, Single Run: RNC or PVC Externally Coated Rigid Steel Conduit where required by NEC 517.13.
4. Underground, Grouped: RNC or PVC Externally Coated Rigid Steel Conduit where required by NEC 517.13.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

- B. Indoors: Use the following wiring methods:

1. Exposed: EMT or “Wiremold” metallic raceways or equal.
2. Exposed in public areas: “Wiremold” metallic raceways or equal. Use of exposed raceways in public areas must be approved by the architect prior to installation for each location. Use of exposed EMT in areas visible to the public is not allowed unless specifically approved by the architect prior to installation. Replacement of unapproved installations of exposed raceways will be at the expense of the contractor if deemed necessary by the architect or engineer.
3. Concealed: EMT or MC-Cable. Note: MC-Cable is not approved for “homeruns”
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.
5. Damp or Wet Locations: Rigid steel conduit.
6. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

3.3 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- B. Minimum Raceway Size: 1/2-inch trade size. 3/4-inch minimum for “homeruns”.
- C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.
- D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

- E. Install raceways level and square and at proper elevations. Provide adequate headroom.
- F. Complete raceway installation before starting conductor installation.
- G. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.
- H. Use temporary closures to prevent foreign matter from entering raceways.
- I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- K. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
- L. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
- M. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Transition from nonmetallic tubing to rigid steel conduit or IMC before rising above floor.
- N. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
 - 1. Run parallel or banked raceways together, on common supports where practical.
 - 2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- O. Join raceways with fittings designed and approved for the purpose and make joints tight.
 - 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - 2. Use insulating bushings to protect conductors.
- P. Tighten set screws of threadless fittings with suitable tools.
- Q. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.

- R. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
- S. Install pull wires in empty raceways. Utilize polyester line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.
- T. Telephone and Signal System Raceways: In addition to the above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- U. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.
 - 2. Where conduit pass from the interior to the exterior of a building.
 - 3. Where otherwise required by NEC.
- V. Apply firestopping to cable and raceway penetrations of fire-rated floor, ceiling and wall assemblies to achieve fire-resistance rating of the assembly.
- W. Route conduit through roof openings for piping and ductwork where possible; otherwise, install roof penetrations in accordance with roofing system requirements. Coordinate with roofing installer.
- X. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
- Y. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.
- Z. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
- AA. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.
- BB. Conduits shall not be routed on or above the roof without prior approval from the Engineer. Instead, the branch circuits shall be routed at the structure level below the roof to feed roof-top equipment. When approval is granted to route conduits on or above the roof, the conduits shall be strapped to COOPER industries DB series support blocks at intervals not exceeding NEC requirements. The conduits shall not be rested directly on the roof. It shall be permissible to penetrate the roof adjacent mechanical or electrical equipment to power that respective equipment.

3.4 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers, at least every 8 feet.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install **1/4-inch** diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for **1-1/2-inch** and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than **24 inches** from the box.
- K. Install metal channel racks for mounting cabinets, panelboards; disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 2. New Concrete: Concrete inserts with machine screws and bolts.
 - 3. Existing Concrete: Expansion bolts.
 - 4. Steel: Spring-tension clamps on steel.
 - 5. Light Steel: Sheet-metal screws.

- 6. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

- N. Do not drill structural steel members.
- O. All supports and attachments shall meet project seismic zone requirements.

3.5 BOX INSTALLATION

- A. Do not install boxes back-to-back in walls.
- B. Locate boxes in masonry walls to require cutting of masonry unit edge only. Coordinate masonry cutting to achieve neat openings for boxes.
- C. Provide knockout closures for unused openings.
- D. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches of box.
- E. Use 4" boxes with multiple-gang mudring where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- F. Install boxes in walls without damaging wall insulation.
- G. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- H. Position outlets to locate lighting fixtures as shown on reflected ceiling plans.
- I. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
- J. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud walls, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- K. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- L. For boxes installed in metal construction, use rigid support metal bar hangers or metal bar fastened to two studs or with metal screws to metal studs.
- M. Set floor boxes level and adjust to finished floor surface.
- N. Set floor boxes level and trim after installation to fit flush to finished floor surface.
- O. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- P. Locate pull and junction boxes above accessible ceilings or in unfinished areas. Support pull and junction boxes independent of conduit.
- Q. Minimum box size to be 4" square by 2 1/8" deep.

3.6 LABELING

- A. Label coverplate of all pull and junction boxes by system served. Indicate panel circuits for power and lighting boxes.

3.7 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 260533

SECTION 260800 - ELECTRICAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The purpose of this section is to specify Division 26 responsibilities in the commissioning process, which are being directed by the CxA.
- B. The list of commissioned equipment and systems is found in Section 019113, 1.6.
- C. Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Division 1. Division 26 shall be familiar with all parts of Division 1 and the Commissioning Plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.2 RESPONSIBILITIES

- A. Electrical Contractors: The commissioning responsibilities applicable to the Electrical contractor are as follows (*all references apply to commissioned equipment only*):
 - 1. Include the cost of commissioning in the contract price.
 - 2. In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.
 - 3. Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
 - 4. Contractors shall provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment.
 - 5. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of start-up and functional testing procedures.
 - a. Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
 - b. The Commissioning Authority may request further documentation necessary for the commissioning process.
 - c. This data request may be made prior to normal submittals.
 - 6. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - 7. During the startup and initial checkout process, execute and document the Electrical-related portions of the prefunctional checklists provided by the CxA for all commissioned equipment.
 - 8. Address current A/E punch list items before functional testing.
 - 9. Correct Electrical deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC and A/E.
 - 10. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
 - 11. Provide training of the Owner's operating personnel as specified.
 - 12. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

13. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

B. Designer/Engineer

1. Refer to Section 019113 for the responsibilities of the Designer/Engineer.

1.3 RELATED WORK

- A. Refer to Section 019113, Part 1.4 for a listing of all sections where commissioning requirements are found.
- B. Refer to Section 019113 Part 1.6 for systems to be commissioned and Part 3 of this section for functional testing requirements.
- C. Refer to Section 260923 for additional lighting control acceptance requirements.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Division 26 shall provide all test equipment necessary to fulfill the testing requirements of this Section.
- B. Refer to Section 019113 Part 2.1 for additional Division 26 requirements.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Division 26 shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 019113 Part 3.3 for additional Division 26 requirements.

3.2 STARTUP

- A. The Electrical contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 019113 Part 3.4. Division 26 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Authority or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA and PM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

3.3 FUNCTIONAL TESTS

- A. Refer to Section 019113 Part 1.6 for a list of systems to be commissioned and to Part 1.3 for a description of the process and to Part 3.5 and this section for specific details on the required functional tests.
- B. For Electrical equipment requiring testing that is not included in the CxA's scope of work, refer to the individual Division 26 sections for specified testing requirements.

3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

- A. Refer to Section 019113 Part 3.6 for specific details on non-conformance issues relating to prefunctional checklists and tests.
- B. Refer to Section 019113 Part 3.5 for issues relating to functional tests.

3.5 OPERATIONS AND MAINTENANCE (O&M) MANUALS

- A. Division 26 shall compile and prepare documentation for all equipment and systems covered in Division 26 and deliver to the GC for inclusion in the O&M manuals, according to Division 1.
- B. The CxA shall receive a copy of the O&M manuals for review.

3.6 TRAINING OF OWNER PERSONNEL

- A. The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 019113 for additional details.

- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 019113 for additional details.
- C. Electrical Contractor: The Electrical contractor shall have the following training responsibilities:
 - 1. The Electrical contractor shall provide designated Owner personnel training as described in the Project Manual.
 - 2. The Electrical contractor will provide the CxA with a training plan and agenda for review prior to the training sessions as described in Section 019113, Part 3.8.

3.7 DEFERRED TESTING

- A. Refer to Section 019113, Part 3.9 for requirements of deferred testing.

3.8 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors will consist of the startup and initial checkout plan described in Section 019113 and the filled out startup, initial checkout and prefunctional checklists.

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.
- B. Related Sections include the following:
 - 1. Section 262726 - Wiring Devices for wall-box dimmers and manual light switches.

1.3 SUBMITTALS

- A. Submit shop drawings and product data, including all wiring diagrams.

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

- A. Line-Voltage Surge Protection: Include in all 120- and 277-V solid-state equipment. Comply with UL 1449.

2.2 TIME SWITCHES

- A. Description: Electromechanical-dial type complying with UL 917.
 - 1. Astronomic dial.
 - 2. Two contacts, rated 30 A at 277-V ac, unless otherwise indicated.
 - 3. Eight-day program uniquely programmable for each weekday and holidays.
 - 4. Skip-day mode.

2.3 LIGHTING CONTROL SYSTEM

- A. Description of Work: Extent of lighting control system work is indicated by drawings, and by the requirements of this section. It is defined to include low voltage lighting control panels, switch inputs, and wiring.

1. Type of lighting control equipment and wiring specified in this section include the following: Low Voltage Lighting Control Panels.

B. SYSTEM DESCRIPTION

1. The lighting control system shall consist of low voltage relay control panels with 32 programmable switch inputs and shall offer 32 control relays.
2. Each low voltage lighting control panel shall be microprocessor controlled with an integral 4 x 16 - 64 character display and with a programming keypad.
3. Programmable intelligence shall include Time-Of-Day control, 32 holiday dates, warn occupants of an impending off, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control.

TOD programming	64 Time-Of-Day/holiday schedules for 365 day
Holidays	32 holiday dates
Warn Off	Flash lights and provide an extra 1 second to 99 minutes of illumination
Preset	Pre-programmed switch patterns
Timed Inputs	Switch input timers 1-999 minutes
Timed Overrides	Timed override 1-999 minutes, resumes to normal schedule
Local Control	From alpha-numeric keypad & local switch
Astronomical	Longitude and latitude input with sunset-sunrise offsets to customize outdoor lighting Clock
Auto Daylight	Automatically adjusts the clock at the appropriate dates, selectable Savings Adjust.
Priorities	Establishes a hierarchy for inputs and network control commands
Masking	Provides permission orientation to switch inputs and network commands thereby ensuring building lighting control integrity.
Soft-Linking	Group linking for rapid programming

4. Relays may be designated as either normally open or normally closed from software. Relay status shall not only disclose commanded relay status but next scheduled state to occur.
5. Each control panel shall provide a Warn Off (flash the lights) to inform the occupants of an impending Off command. The Warn Off command shall provide an adjustable time duration of 1 second to 99 extra minutes. The occupants may exit the premises with adequate lighting or cancel the Warn Off by overriding the lighting zone. This option occurs with all Off commands except local overrides.
6. The controller shall permit lighting to be overridden on for after hours use or cleaning. The controller shall provide optional switch timer assignments or timed overrides. The override choices for various relays shall provide special event occurrences and the controller shall return to the programmed state. Also, the controller shall provide priority and masking choices to customize the functions of switch inputs, thereby enabling switches to function differently at different times of the day to meet special facility operational requirements. These overrides shall be hard-wired inputs.
7. Programming the controller shall be through the local integral keypad. Descriptive information shall assist the user to employ the system without a programming manual.
8. Priorities and/or Masking shall be assigned to inputs, telephone override, and global commands to insure building integrity. Priorities enable or disable the inputs based on Time-Of-Day scheduling in the controller. Masks shall permit: On only, Off only and On & Off control for intelligent after hours utilization of the controlled facility
9. The lighting control system may be fully programmed through PC programming software. Programming shall be permitted through a direct RS-232 or RS-485 connection, and modem.

C. HARDWARE FEATURES

1. Operator Interface: The control panel programming interface resides in firmware in the control panel. The programming interface shall consist of a circuit board mounted keypad capable of linking switch inputs to relay outputs and schedule assignments. Systems that utilize blocking diode technology for relay assignments shall not be acceptable.

The integral keypad shall provide access to the main programming features. The keypad shall permit the user to manually command any or all relays individually. Each panel shall control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks shall not be permitted.

2. Contact inputs: The control system shall permit 32 dry contacts (Digital/Switch Inputs) for override purposes. Momentary 3 wire or 2 wire (toggle) inputs shall be supported. Maintained contacts shall be supported as 2 wire (SPST) inputs.

Inputs shall be dry contacts (24 VDC @ 12 ma. internally supplied to the inputs). An input shall be software linked to any number of relays for override control.

The controller shall provide timers for each switch input. Each switch input timer shall be capable of 0-999 minutes. Software shall enable or disable switch inputs based on Time Of Day scheduling.

3. Relay Type: The system shall utilize control relays which are rated to 20 amps at 277 VAC. The relays shall be magnetically held and are provided in groups of eight. Relays that are latched or mechanically held are not acceptable. The relays shall be rated for 10 million mechanical operations. A limited 10 year warranty shall be provided on the individual relays.
4. Photocell Control: The controller shall accept user adjustable ambient light sensors. The controller shall provide power for the sensor thereby eliminating any external power supply. Sensors shall provide for both outdoor and indoor applications and provide a dry contact to the controller once the threshold is reached. The sensor shall provide user adjustable dead band control.
5. Modular Design: The control system shall employ all modular connectors to avoid repeat wiring in case of component failure. The system CPU board shall be mounted on quick release hinge pins that shall permit an entire change out of the processor and input board in less than 1 minute.

All connections for the switch inputs shall incorporate modular connectors. The relay board shall be modular and designed for rapid field replacement or upgrading. Systems that do not employ modular connectors shall not be acceptable.

6. Hardware Output Options
 - a. Latching Relay Card (LRC): The controller shall provide an option for remote placement of the control relays. A modular card shall connect into the relay compartment. Twisted (3) conductor cable shall power and control the remote mounted relays. Maximum distance is 500 feet employing 18 AWG conductor.
 - b. Modular Relay Card (MRC): The controller shall provide an option for modular relay control. The Modular Relay Card (MRC) shall offer the feature of controlling two pole voltages such as 208, 240, and 480VAC in a Normally Open or Normally Closed configuration. Single pole is offered for 120 and 277VAC in a Normally Open and Absolute Zero Configuration. This relay card shall also provide visual indication of relay status. Relays shall be individually exchangeable with plug in low voltage connectors. Combinations of relays shall be permitted since relay modules shall snap into and lock in location. Two pole modules require two relay locations for a maximum of four two pole relays per card. All other relay modules use 1 relay location for a maximum of eight per card. All Modular Relay Card components shall be warranted for 10 years.

- c. Two Pole Relay Card (TPRC): The controller shall provide an option for two pole relay control. The Two Pole Relay Card TPRC shall offer the feature of controlling two pole voltages such as 208, 240, and 480 VAC lighting loads at 20 amps. The relays shall be modular in design and offer manual hand override control. This optional relay card shall also provide a visual indication of relay status. The 208, 240 VAC version shall provide 8 relays per card whereas the 480 VAC version shall provide 4 relays per card. Combinations of relays shall be permitted since relays shall snap into location.
 - d. Automatic Relay Card (ARC): The system shall utilize hybrid control relays that are rated to 20 amps at 277 VAC. The hybrid relay shall combine a high speed electronic switch with a mechanical relay to create a unique switching device. The hybrid design shall look at each AC phase and shall close the electronic switch precisely at the absolute zero crossing. The mechanical relay in parallel shall follow and close after the in-rush current condition. The relay shall provide an integral switch for both manual hand operation and visual indication of relay status. The relays shall be rated for 10 million mechanical operations. A limited 2 year warranty shall be provided on the individual relays.
 - e. Lighted Switch Card (LSC): The controller shall provide an option for pilot light wall switch annunciation. A modular card shall connect into the controller board and shall provide power to illuminate pilot light switches. This option shall confirm relay operation. When a relay is in the "ON" position the pilot light switch shall be illuminated.
7. Diagnostic Aids: Each control panel shall incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids shall guide the individual in rapid troubleshooting of the system.

The control panels shall employ both a backlit supertwist LCD and LED's that indicates:

- POWER (LED)
- SYSTEM OK (LED)
- NETWORK COMMUNICATIONS (LED)
- ON/OFF STATUS of EACH RELAY (LED & LCD)
- SYSTEM CLOCK and DATE (LCD)
- PROGRAMMING CONFIRMATION (LCD)
(TOD, HOLIDAY, ON/OFF, & PRESET)

Control systems that do not provide visual self help diagnostics shall not be acceptable.

8. Memory Back-up: The system shall utilize a memory back-up device that is system integrated and shall be non-serviceable. The data in RAM shall be protected against power interruptions lasting as long as 7 days. The power interrupt protection circuit shall be entirely maintenance-free.
9. Multi-tapped Transformer: The control panel shall incorporate the use of a multi-tapped transformer. The panel shall not require specification of voltage for each

control location. The voltages of 120 & 277 VAC shall be available with each control panel.

10. Status Indication of Relays: The system shall provide visible status indication of all relays through the window of each control panel. The visual indication shall disclose On/Off status and relay number.
11. Service Override & Priority Override: The control panel shall provide a three position master-service override for the control unit. The service override shall not be accessible from the exterior.

The master service override provides a single three position switch with the option of All Off, Auto, and All On, respectively. This master switch shall operate all of the relays in the controller. This switch shall override and supersede all commands from the logic board when the switch is in the All On or All Off position. The master switch shall function to override all the relays should the logic board programming differ from the space function.

The system shall remember the last command to the individual relays. Upon returning the master override switch to the Auto position, the relays shall return to the most recent command state. This will occur even if the last command happened during the master override condition.

Additionally, the system shall provide external priority override for the entire panel. Through an externally maintained contact the override card shall place the panel in a priority state. This external contact will supersede any other programmed state and will command all the relays ON or OFF depending on operational choice. This priority state will continue until the external contact is removed. Once the external override is removed the control panel will return the relays to the appropriate programmed state.

12. Lockable Enclosure: Each control panel shall be enclosed in a lockable NEMA class 1 enclosure. The enclosure shall be manufactured out of 1/16" steel and shall provide pre-punched knockouts for efficient installation.
13. Panels: The low voltage controller shall exist in two sizes of relay enclosures. The enclosure maximum sizes shall be 32 relays per cabinet. The 16 size will employ two relays cards and the 32 will utilize 4 relay cards. Relays shall be provided in groups of eight relays per card.
14. High Voltage Barriers: The low voltage controller shall provide as an option the ability to provide a barrier for either voltage separation or emergency circuit separation. The 16-size enclosure shall permit one barrier and the 32-size enclosure shall permit up to three locations where the barrier(s) may be installed. The barrier shall be painted red to denote the difference.
15. Modem: The control system shall be capable of modem communications. Each control panel shall provide a serial communications port for external telecommunications. The modem shall utilize the Hayes compatibility standard and

enable modem access as defined by the Bell 212A and CCITT V.22 protocol standards.

16. Telephone Overrides (TIM): The control system shall provide intelligent software for the Telephone Interface Module (TIM) option. The optional TIM unit shall allow modem communications and touch tone overrides from any touch tone phone. The control system shall be multi-tasking and permit up to one TIM for each control panel.

Override Operation: Touch-tone interface shall permit the control panel to command pre-assigned control points On\ Off. All user interfaces shall be through the twelve Touch-tone keys on the telephone. All entries into the override system shall be prompted by a digitized voice. Systems not employing voice guided override instruction are not acceptable.

The TIM shall provide individual control passwords. Each password shall allow a preset group designation (number of relays) and the duration of the telephone override. TIM shall also provide a password to prevent entry into the override control system.

17. Software: System provided shall include the manufactures PC based interface software package. The PC based interface software shall provide access to lighting control system files within a Microsoft Windows environment. The software package shall allow individual panel programming to be executed locally, direct connection, Ethernet connection or remotely through a modem. The central programming software shall permit the user to modify the control panel programming or configuration in an "OFF-LINE" mode. This software package shall store all programmed data and archive for future use. Systems using third party software are not acceptable.

The following features shall be standard in the PC based software:

- a. Standard Software Features:
 - i. Real Time Relay Status Monitoring
 - ii. Alpha-Numeric Descriptors
 - iii. Communications: Direct, Network, Ethernet and Modem
 - iv. Network Status Indication
 - v. Global Software Modifications
 - vi. Manual Relay Commands
 - vii. Remote Pattern Commands
 - viii. Preset Options
- b. File Maintenance
 - i. Archive Programs
 - ii. Data Base Restoration
 - iii. Uploading and Downloading of Programs

Software package shall permit the PC to be utilized for other functions (i.e. word processing, data-base, & etc..) besides lighting control. Systems that require an

"on-line" dedicated computer for control system operation shall not be acceptable.

18. PC Interface (RS-232 port): The controller shall permit PC programming through software. The controller shall provide a RJ-12 connection for RS-232 programming. Programming shall be permitted through either a local connection or remotely through a modem. PC software shall permit multiple file storage for data archival and for seasonal facility requirements. Operator commands may be issued directly from the PC keyboard.

D. MANUFACTURERS

1. Cooper Controls, Greengate
2. Lutron
3. Lighting Control & Design
4. Lightolier

E. PRODUCT SUPPORT AND SERVICE

1. Factory Support: Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

F. WARRANTY

1. Manufacturer shall supply a 2 year warranty on all hardware and software. A limited 10 year warranty shall be provided on the standard relay card.

2.4 PHOTOELECTRIC RELAYS

- A. Description: Solid state, with single-pole, double-throw dry contacts rated to operate connected relay or contactor coils or microprocessor input, and complying with UL 773A.
- B. Light-Level Monitoring Range: 0 to 3500 fc, with an adjustment for turn-on/turn-off levels.
- C. Time Delay: Prevents false operation.
- D. Outdoor Sealed Units: Weather tight housing, resistant to high temperatures and equipped with sun-glare shield and ice preventer.

2.5 OCCUPANCY SENSORS

- A. Occupancy sensors indicated on the plans are to establish room controls and sensor quantities. The contractor is to verify sensor placement with the local manufacturer's representative or the manufacturer to ensure proper coverage and functionality of the specific sensor(s) installed. The contractor is to return and make any adjustments necessary to the

occupancy sensor settings and/or placement needed to maintain proper functionality within 30 days after the owner/tenant takes occupancy of the project.

- B. Lighting control system shall include all occupancy sensors, power packs, and control wiring required to form a complete system.
- C. All occupancy sensors shall be dual/multi technology, manufactured by Unenco, Wattstopper, Lightolier Controls, Sensor Switch, or pre-approved equal unless otherwise noted.
- D. Ceiling and Wall Mount Units: Shall utilize dual/multi technology detection methods. Unit receives control power from a separately mounted auxiliary power and control unit, and operates power switching contacts in that unit.
- E. Switch-Box-Mounting Units: Shall utilize dual/multi technology detection methods. Unit receives power directly from switch leg of the 120- or 277-V ac circuit it controls and operates integral power switching contacts. Unit is to have integral manual controls and is to be mounted at standard switch height.
- F. Operation: Turns lights on when room or covered area is occupied and off when unoccupied, unless otherwise indicated.
 - 1. Time Delay for Turning Lights Off: Adjustable over a range from 1 to 30 minutes, minimum. Time delay to be set at 20 minutes unless otherwise directed. Contractor shall verify time delay with the owner/tenant prior to final occupancy.
 - 2. Manual Override Switch: Where indicated on drawings; turns lights off manually regardless of elapsed time delay.
 - 3. Sensor shall be located and/or adjusted to detect occupancy within 1-foot of entry into room or area controlled by the occupancy sensor.
- G. Auxiliary Power and Control Units: As follows:
 - 1. Relays rated for a minimum of 20-A normal ballast load.
 - 2. Sensor Power Supply: Rated to supply the number of connected sensors.
 - 3. Relays shall have an auxiliary contact(s) for integration with HVAC or other building control systems.
- H. Passive-Infrared Type: Detects occupancy by a combination of heat and movement in zone of coverage.
- I. Ultrasonic Type: Emits a beam of ultrasonic energy and detects occupancy through use of Doppler's principle in discerning movement in zone of coverage by sensing a change in pattern of reflected ultrasonic energy. Ultrasonic frequency shall be 25 Khz or greater and sensor shall be temperature and humidity resistant.
- J. Dual-Technology Type: Uses a combination of passive-infrared and ultrasonic or microphonic detection methods to distinguish between occupied and unoccupied conditions for area covered. Particular technology or combination of technologies that controls each function (ON or OFF) is selectable in the field by operating controls on unit.

- K. All sensors shall be capable of operating normally with electronic ballast and compact fluorescent systems.
- L. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
- M. All sensors shall have readily accessible, user adjustable controls for time delay and sensitivity. Controls shall be recessed to limit tampering.
- N. In the event of failure, a bypass manual "override on" feature shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly. The override feature shall be designed for use by building maintenance personnel and shall not be readily accessible by building occupants.
- O. All sensors shall provide an LED indication light to verify that motion is being detected and that the unit is working.
- P. All sensors shall have no leakage current in OFF mode and shall have voltage drop protection.

2.6 MULTIPOLE CONTACTORS AND RELAYS

- A. Description: Electrically operated and mechanically held, and complying with UL 508 and NEMA ICS 2.
 - 1. Current Rating for Switching: UL listing or rating consistent with type of load served.
 - 2. Control Coil Voltage: Match control power source.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment level and plumb and according to manufacturer's written instructions.

3.2 CONTROL WIRING INSTALLATION

- A. Install wiring between sensing and control devices according to manufacturer's written instructions.
- B. Wiring Method: Install all wiring in raceways.
- C. Bundle, train, and support wiring in enclosures.
- D. Ground equipment.

- E. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.3 IDENTIFICATION

- A. Provide Brady wire markers or equivalent on all conductors.

3.4 FIELD QUALITY CONTROL

- A. Inspect control components for defects and physical damage.
- B. Verify settings of photoelectric devices with photometer.
- C. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:
 - 1. Continuity tests of circuits.
 - 2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
- D. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
- E. The Lighting Control Panel shall be tested and listed under the UL 906 Energy Management Equipment Standards.

3.5 CLEANING

- A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

END OF SECTION 260923

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:
 - 1. Lighting and appliance branch-circuit panelboards.
 - 2. Distribution panelboards.
- B. Related sections:
 - 1. Section 260501 - Field Test and Operational Check.
 - 2. Section 260526 - Grounding.

1.3 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. UL listing for series rating of installed devices.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- D. Maintenance Data: For panelboards and components, include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA PB 1.
- C. Comply with the NEC.

1.5 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. Panelboards, Overcurrent Protective Devices and Accessories:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Div.
 - c. Siemens
 - d. Square D Co.; Schneider Electric Brands
 - e. Or approved equal.

2.2 FABRICATION AND FEATURES

- A. Enclosures: Flush or surface mounted cabinets (as indicated on drawings). Construct cabinets with code gauge galvanized steel. Provide minimum 20" wide cabinets and extra wiring space where incoming feed-through or parallel lines are shown. NEMA PB 1, Type 1, to meet environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
- B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
- C. Doors: Provide door-in-door construction, made of cold-rolled steel. Inner door shall provide access to breaker handles and outer door shall provide access to wiring space as well. Inner door shall be

completely flush with no visible bolts, screw-heads or hinges and with flush catch and lock. Outer door shall have concealed hinges, flush catch and lock to match inner door, located in line with inner door catch. (Tee bar handles are not acceptable).

- D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
- E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.
- F. Bus: Hard-drawn copper, 98 percent conductivity. Attach circuit breakers to bus so that circuits 1, 3, and 5; 2, 4, and 6, or any three similarly numbered circuits form one three-phase, four-wire circuit.
- G. Main and Neutral Lugs: Compression or mechanical type suitable for use with conductor material.
- H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- I. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- J. Isolated Equipment Ground Bus: Where indicated on drawings - Adequate for branch-circuit equipment ground conductors; insulated from box.
- K. Extra-Capacity Neutral Bus: Where indicated on drawings, neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Where indicated on plans, On 120/208Y Panels fed by K factor Type Transformer.
- L. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor. Where indicated on plans.
- M. Gutter Barrier: Arrange to isolate individual panel sections.
- N. Feed-through Lugs: Compression or mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device. For two-section panels.
- O. Panels located adjacent to each other shall have identically sized enclosures and trims.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating. If not series rated: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices:

1. 120/208Y volt branch circuit panelboards: Quick-make, quick-break, molded case plug-in type designed for 120/208Y volt, three-phase, four-wire service with minimum 10,000 amperes rms short circuit rating.
2. 277/480Y volt branch circuit panelboards: Molded case bolt-on type designed for 277/480Y volt, three-phase, four-wire service with minimum 14,000 amperes rms short circuit rating.
3. Provide multi-pole units with common trip elements.
4. Breaker shall have center-tripped position in addition to the ON and OFF positions.
5. Provide lockouts for all circuits that should not be inadvertently tripped (as indicated on the drawings).

2.5 DISTRIBUTION PANELBOARDS

- A. Dead-front, dead-rear, Nema 1 or 3R enclosure as indicated, designed for use on a three-phase, four-wire, 120/208Y or 277/480Y volt system. See drawings for additional details.
- B. Construction: Code gauge galvanized steel fully flanged for strength and rigidity. Door and trim shall be cold-rolled steel, code gauge. Provide concealed butt hinges and 3-point catch and lock. Provide separately hinged or bolted vertical access doors over lug and wiring spaces.
- C. Bus Bars: Panel shall be fully bussed. Shall be used throughout and shall be hard-rolled, electrolytic copper of 98% conductivity designed for a maximum 1000 amperes per square inch. Bars shall be factory pre-drilled to accept future field installation of 2 or 3 pole circuit breakers in any combination. Brace all bus bars for required short circuit rating of the panel, but in no case less than 35,000 amperes rms.
- D. Main Overcurrent Protective Devices: Circuit breaker unless otherwise noted.
- E. Provide handle locking devices for all circuit breakers.
- F. Provide engraved nameplates with minimum ¼" high letters secured to panel front and for each circuit protective device in panel.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Main Breaker (or Feeder) Assemblies rated for 1200 Amps:
 1. Main (or feeder) breakers rated for 1200 Amp may be Molded Case with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit breakers shall have the following features:
 - a. UL listed for 80 percent load application unless otherwise indicated on plans as 100% rated.
 - b. Adjustable [L] Long time time-delay and ampere setting.
 - c. Adjustable [S] Short time-delay and pick-up.
 - d. Adjustable [I] Instantaneous trip.
 - e. For 277/480Y systems rated 1000 Amp or higher - Adjustable [G] Ground fault pick-up and delay is required.

- f. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
- g. Adjustable [R] Reduced Energy Let-Through (RELT) Instantaneous trip. This feature shall be provided on breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.
- h. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard.
- i. Short circuit, overload and ground fault trip indicators.

B. Feeder Circuit Breaker Assemblies 400 Amps or larger:

- 1. Feeder Circuit breakers 400 Amps or larger shall be digital solid state true RMS sensing Molded Case Circuit Breakers with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit Breakers shall have the following minimum features:
 - a. UL listed for 80 percent load application unless otherwise indicated on plans.
 - b. Long time pickup (ampere setting) determined by interchangeable rating plug .
 - c. Adjustable instantaneous with short time tracking function.
 - d. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
 - e. Circuit breaker handle accessories shall provide provisions for locking handle in the 'ON' or 'OFF' position
- 2. Where specifically indicated or required by NEC
 - a. Adjustable [L] Long time time-delay and ampere setting.
 - b. Adjustable [S] Short time-delay and pick-up.
 - c. Adjustable [I] Instantaneous trip.
 - d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
 - e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
 - f. Short circuit, overload and ground fault trip indicators.
 - g. Trip device of circuit breakers shall be of same type for tripping coordination.

C. Feeder Circuit Breaker Assemblies 150 Amp and below:

- 1. Feeder Circuit breakers 150 Amp and below shall be thermal Magnetic Circuit breaker : Inverse time Current element for low level overloads, and instantaneous magnetic trip element for short circuits., unless otherwise indicated or required to meet Section 2.4 C above. Minimum features below:
 - a. UL listed for 80 percent load application unless otherwise indicated on plans.

- b. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
 - c. Circuit breaker handle accessories shall provide provisions for locking handle in the 'ON' or 'OFF' position
- 2. Where specifically indicated or required by NEC
 - a. Adjustable [L] Long time time-delay and ampere setting with Long time pickup (ampere setting) determined by interchangeable rating plug.
 - b. Adjustable [S] Short time-delay and pick-up.
 - c. Adjustable [I] Instantaneous trip.
 - d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
 - e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
 - f. Short circuit, overload and ground fault trip indicators.
 - g. Trip device of circuit breakers shall be of same type for tripping coordination.
- D. General Breaker Requirements:
 - 1. Minimum interrupting capacity shall match the minimum required interrupt rating of the panel.
 - 2. Standard frame sizes, trip ratings, and number of poles.
 - 3. Lugs: Mechanical or compression style, suitable for number, size, trip ratings, and material of conductors.
 - 4. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 5. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
 - 6. Shunt Trip: 120-V trip coil energized from separate circuit.

PART 3 -EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Clearances: Minimum code required clearances around panelboards must be maintained.
- C. Mounting Heights: Top of trim 78 inches above finished floor, unless otherwise indicated.
- D. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Mounting Hardware: Provide all necessary blocking, channels and other hardware for securing panelboards to wall, column or other parts of building structure.

- F. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- G. Install filler plates in unused spaces.
- H. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components.
- B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Label shall include panel designation, voltage and phase in minimum 1/4" high letters.

3.3 CONNECTIONS

- A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.4 FIELD QUALITY CONTROL

- A. Testing: Refer to Section 16040 – Field Test and Operational Check.
- B. After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Balancing Loads: After Substantial Completion, measure load balancing and make circuit changes as follows:
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit breaker trip ranges.
- B. Adjust all operating mechanisms for free mechanical movement.

3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416

SECTION 262418 – MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes ac general-purpose starters rated 600 V and less.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed starter. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each enclosed starter.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. UL listing for series rating of overcurrent protective devices in combination starters.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination starters.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around enclosed starters where pipe and ducts are prohibited. Show enclosed starter layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Maintenance Data: For enclosed starters and components, include the following:
 - 1. Routine maintenance requirements for enclosed starters and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

- E. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain, within 100 miles of project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Source Limitations: Obtain enclosed starters of a single type through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with the NEC.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed starters indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed starters from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 COORDINATION

- A. Coordinate layout and installation of enclosed starters with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate features of enclosed starters and accessory devices with pilot devices and control circuits to which they connect.
- C. Coordinate features, accessories, and functions of each enclosed starter with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: Furnish one set of three of each type and rating.
 - 2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Manual and Magnetic Enclosed Starters:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.
 - c. Rockwell Automation Allen-Bradley Co.; Industrial Control Group.
 - d. Square D Co.
 - e. Siemens
 - f. Or approved equal.

2.2 MANUAL ENCLOSED STARTERS

- A. Description: NEMA ICS 2, general purpose, Class A, with toggle action and overload element.

2.3 MAGNETIC ENCLOSED STARTERS

- A. Description: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.
- B. Control Circuit: 120 V; obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
- C. Combination Starter: Factory-assembled combination starter and disconnect switch.
1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.
 2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
 3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

2.4 ENCLOSURES

- A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
1. Outdoor Locations: NEMA 250, Type 3R.
 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
5. A minimum wiring space of 2" clear on both sides and 4" clear top and bottom. Open and accessible through the door.

2.5 ACCESSORIES

- A. Devices shall be factory installed in starter enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. All starters shall include a terminal strip for all control connections and be accessible through front door.
- F. All starters to be furnished with 4 sets of normally open / normally closed auxiliary contacts.

2.6 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed starters before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive enclosed starters for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed starter to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting starter functions.
- B. Select horsepower rating of starters to suit motor controlled.

3.3 INSTALLATION

- A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For starters not at walls, provide freestanding uni-strut racks.
- B. Enclosed Starter Fuses: Install fuses in each fusible switch.

3.4 IDENTIFICATION

- A. Provide engraved lamacoid nameplate for each starter indicating equipment served.

3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed starters according to Section 260519 - Conductors and Cables.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed starter circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

- A. Conduit installation requirements are specified in other Sections 260533 – Raceways and Boxes. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.7 FIELD QUALITY CONTROL

- A. Verify that enclosed starters are installed and connected according to the contract documents.
- B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
- C. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 CLEANING

- A. Clean enclosed starters internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262418

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes receptacles, switches, and finish plates.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

- A. Submit shop drawings and product data.

1.5 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. Wiring Devices:
 - a. Bryant; Hubbell, Inc.
 - b. GE Company; GE Wiring Devices.
 - c. Hubbell Wiring Device – Kellems
 - d. Leviton Manufacturing Co., Inc.
 - e. Pass & Seymour/Legrand; Wiring Devices Div.
 - f. Cooper Wiring Devices
 - g. Or approved equal.

2. Wiring Devices for Hazardous (Classified) Locations:
 - a. Crouse-Hinds Electrical Co.; Distribution Equipment Div.
 - b. Or approved equal.
3. Multi-outlet Assemblies:
 - a. Wiremold.
 - b. Hubbell, Inc.; Wiring Devices Div.
 - c. Or approved equal.

2.2 RECEPTACLES

- A. Straight-Blade and Locking Receptacles: Specification grade (construction specification grade prohibited), white color.
- B. GFCI Receptacles: Duplex convenience receptacle with integral ground fault current interrupter. White color
- C. Isolated-Ground Receptacles: Equipment grounding contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from mounting strap, orange plastic face, specification grade.
 1. Devices: Listed and labeled as isolated-ground receptacles.
 2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.
- D. TVSS Receptacles: Duplex type, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground, blue plastic face.
- E. Multit-Outlet assemblies: Metal with White color finish.

2.3 SWITCHES

- A. Snap Switches: General-duty, quiet type, rated 20 amperes, 120/277 volts AC. Handle: white plastic. Pilot light type (where indicated): lighted handle.
- B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible and electromagnetic noise filters.
 1. Control: Continuously adjustable slide. Single-pole or three-way switch to suit connections.
 2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable slide; single pole with soft tap or other quiet switch; electromagnetic filter to eliminate noise, RF, and TV interference; and 5-inch wire connecting leads.
 3. Fluorescent Lamp Dimmers: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming to a maximum of 1 percent of full brightness.

2.4 WALL PLATES

- A. Single and combination types match corresponding wiring devices.
 - 1. Cover plate: Smooth white plastic.
 - 2. Cover plate for surface mounted devices: Galvanized steel.
 - 3. Weatherproof cover plate: While in use, gasketed, cast metal, hinged device covers.
 - 4. Plate-Securing Screws: Metal with head color to match plate finish.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies plumb and secure.
- B. Install wall plates when painting is complete.
- C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.
- D. Do not share neutral conductor on load side of dimmers.
- E. Arrangement of Devices: Unless otherwise indicated, mount flush, vertically, with height as indicated or six inches above counters.
- F. Group adjacent switches under single, multigang wall plates.
- G. Protect devices and assemblies during painting.
- H. Install wall switches with off position down.
- I. Install cover plates on switch, receptacle, and blank outlets.

3.2 IDENTIFICATION

- A. Switches and receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on the outside of the face plate for receptacles and on the inside of the face plate for switches; utilize durable wire markers or tags within all outlet boxes. Labels shall be Brother 1/2" TZ tape, black ink on clear, extra-strength adhesive tape, with size 18 text or engineer approved equal. Use matching label printer.

3.2 CONNECTIONS

- A. Connect wiring device grounding terminal to outlet box with bonding jumper.
- B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.
- C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.4 FIELD QUALITY CONTROL

- A. Test wiring devices for proper polarity and ground continuity. Check each device to verify operation.
- B. Test GFCI operation according to manufacturer's written instructions.
- C. Replace damaged or defective components.

3.5 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, starters, and motor control centers; and spare fuse cabinets.

1.3 SUBMITTALS

- A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Provide fuses from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NEMA FU 1.
- D. Comply with the NEC.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.

- 1. Fuses: Furnish one set of three of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:

- 1. Cooper Industries, Inc.; Bussmann Div.
 - 2. Gould Shawmut.
 - 3. Tracor, Inc.; Littelfuse, Inc. Subsidiary.
 - 4. Or approved equal.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

- A. Cabinet: Wall-mounted, 0.05-inch thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
 - 4. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare fuse cabinet.

3.3 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

SECTION 262815 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 WORK INCLUDED

- A. Provide and install motor disconnects.
- B. Provide and install circuit disconnects.

1.3 REFERENCES

- A. Underwriters' Laboratory, Inc. - Annual Product Directories.
- B. NEMA - Classification of Standard Types of Nonventilated Enclosures for Electric Controllers.

1.4 REGULATORY REQUIREMENTS

- A. Conform to National Electrical Code and to applicable inspection authority.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Cutler-Hammer/Westinghouse, General Electric, Siemens, Square D, or approved equal.

2.2 COMPONENTS

- A. Motor and circuit disconnects shall have an Underwriters' Laboratory label.
- B. Single Phase 120 Volt Disconnect Switches: Single pole toggle switch with thermal overload motor protection where indicated. A Horse Power rated switch may be used where fractional horse power motors have internal overload protection.
- C. Single or Three Phase Motor Disconnect Switches: two or three pole heavy duty or fusible where other loads are on same circuit, 250 or 600 volt as required in NEMA Type 1, 3R, or 4 enclosures designed to reject all except Class 'R' fuses.

2.3 ACCEPTABLE MANUFACTURERS - FUSES

- A. Cooper Bussmann, Edison, Littelfuse, Ferraz Shawmut, or approved equal.

2.4 FUSES

- A. As indicated on the drawings. All shall be of the same manufacturer. Provide one spare set of fuses (minimum of three) for each current rating and type used. See Section 262813.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor and circuit disconnect as indicated on Drawings and as required by Code. Where fuses are indicated, provide fuses correlated with full load current of motors provided.

END OF SECTION 262815

SECTION 263213 - PACKAGED ENGINE GENERATORS AND TRANSFER SWITCHES

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

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

1.2 SCOPE OF WORK

- A. Provide, install, and acceptance test a complete and operable Emergency/Standby electric generating system, including all devices and equipment specified herein, as shown on the drawings, or required for the service. Equipment shall be new, factory tested, and delivered ready for installation.

1.3 APPROVED MANUFACTURERS

- A. Onan, Caterpillar, Kohler, or Generac.

1.4 SUBMITTALS

- A. Provide four (4) sets of the following information for review:
 - 1. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
 - 2. Manufacturer's certification of prototype testing.
 - 3. Manufacturer's published warranty documents.
 - 4. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
 - 5. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
 - 6. Manufacturer's installation instructions.

1.5 WARRANTY

- A. Shall be provided for all products against defects in materials and workmanship for one year period from the start-up date.

1.6 SUPPLIER

- A. The supplier shall be the manufacturer's authorized distributor, who shall provide initial start-up services, conduct field acceptance testing, and warranty service. The supplier shall have 24-hour service availability and factory-trained service technicians authorized to perform warranty service on all products provided.

1.7 MANUALS

- A. Operators and spare parts manuals shall be provided for all system equipment. The manuals shall include outline, interconnection, wiring, and control drawings accurately describing the equipment provided. Provide ladder logic for all programmable logic controllers in the system.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every ten of each type and rating, but not less than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but not less than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 DIESEL ENGINE GENERATOR SET

- A. 2 or 4 cycle, 1800 rpm, diesel engine generator set. Generator set ratings: size as indicated on the drawings, standby rating, based on site conditions noted below. System voltage of: 277/480 Volts AC, Three phase, Four-wire, 60 hertz.
- B. Site Conditions: The generator set shall be rated for the following site conditions: altitude 2800 feet, ambient temperatures up to 104 degrees F. The rating of the generator shall be no more than 5% under the KW rating indicated on the plans when all derating factors for the generator set are considered for the above site conditions based on manufactures data.
- C. Prototype tests and evaluation
 - 1. Prototype tests shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement. Prototype testing shall comply with the requirements of NFPA 110 for level 1 systems.
- D. Performance
 - 1. Voltage regulation shall be +/- 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed +/- 0.5 percent.

2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
3. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

E. Engine

1. The engine shall be diesel, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Engine accessories and features shall include:
 - a. An electronic governor system shall provide automatic isochronous frequency regulation.
 - b. Skid-mounted radiator and cooling system rated for full load operation in 104 degrees F ambient as measured at the generator air inlet. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with 50/50 ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact per OSHA requirements.
 - c. An electric starter(s) capable of three complete cranking cycles without overheating.
 - d. Positive displacement, mechanical, full pressure, lubrication oil pump.
 - e. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
 - f. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element.
 - g. Replaceable dry element air cleaner with restriction indicator.
 - h. Flexible supply and return fuel lines.
 - i. Engine mounted battery charging alternator, 45 ampere minimum, and solid-state voltage regulator.

F. AC Generator

1. The AC generator shall be; synchronous, four pole, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system.
2. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

G. Generator Set Control

1. The generator set shall be provided with a microprocessor-based control system, which is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered. All switches, lamps and meters shall

be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The generator set mounted control shall include the following features and functions:

- a. Three position control switch labeled RUN/OFF/AUTO.
 - i. In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
- b. Red "mushroom-head" push-button EMERGENCY STOP switch.
 - i. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
- c. Generator Set Alarm and Status Message Display:
 - i. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel:
 - a low oil pressure (alarm)
 - b low oil pressure (shutdown)
 - c oil pressure sender failure (alarm)
 - d low coolant temperature (alarm)
 - e high coolant temperature (alarm)
 - f high coolant temperature (shutdown)
 - g engine temperature sender failure (alarm)
 - h low coolant level (alarm or shutdown--selectable)
 - i fail to crank (shutdown)
 - j overcrank (shutdown)
 - k overspeed (shutdown)
 - l low DC voltage (alarm)
 - m high DC voltage (alarm)
 - n weak battery (alarm)
 - o low fuel-daytank (alarm)
 - p high AC voltage (shutdown)
 - q low AC voltage (shutdown)
 - r under frequency (shutdown)
 - s over current (warning)
 - t over current (shutdown)
 - u short circuit (shutdown)
 - v over load (alarm)
 - w emergency stop (shutdown)

2. Engine Status Monitoring:

- a. The following information shall be available from a digital status panel on the generator set control :
 - i. engine oil pressure (psi or kPA)
 - ii. engine coolant temperature (degrees F or C)
 - iii. engine oil temperature (degrees F or C)
 - iv. engine speed (rpm)
 - v. number of hours of operation (hours)
 - vi. number of start attempts
 - vii. battery voltage (DC volts)
3. Control Functions:
 - a. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.
 - b. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
 - c. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
 - d. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
 - e. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.
4. Alternator Control Functions:
 - a. The generator set shall include an automatic voltage regulation system which is matched and prototype tested with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58 HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alpha-numeric LED readout to indicate setting level.
 - b. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.
 - c. Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down

and lock out the generator set when output current level approaches the thermal damage point of the alternator.

- d. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.
- e. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded .
- f. An AC over/under voltage monitoring system which responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.
- g. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 10VDC or more than 16 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 7 volts for more than two seconds a "weak battery" alarm shall be initiated.

H. Base

1. The engine-generator set shall be mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.

I. Generator set auxiliary equipment and accessories

1. Vibration Isolation

- a. Vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.

2. Exhaust Silencer

- a. Exhaust muffler shall be provided for each engine, size and type as recommended by the generator set manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the generator set manufacturers recommendations and applicable codes and standards.

3. Starting and Control Batteries

- a. Starting battery bank, calcium/lead antimony type, 24 volt DC, sized as recommended by the generator set manufacturer, shall be supplied for each generator set with battery cables and connectors.

J. Generator set main circuit breaker

1. Generator main circuit breaker: set-mounted and wired, UL listed, molded case type with electronic trip unit, sized as indicated on the drawings, 3 pole, 600 volts. Submittals shall demonstrate that the circuit breaker provides proper protection for the alternator by a comparison of the trip characteristic of the breaker with the thermal damage characteristic

of the alternator. Field circuit breakers shall not be acceptable for generator overcurrent protection.

K. Remote annunciator

1. Provide and install a 20-light LED remote alarm annunciator with horn, located as shown on the drawings or in a location which can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for high battery voltage, low battery voltage, loss of normal power to the charger. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2.

L. Sub-base fuel storage tank

1. Provide a dual wall sub-base fuel storage tank with 24 hour (600 gallon maximum) capacity. The tank shall be constructed of corrosion resistant steel and shall be UL listed. The equipment, as installed, shall meet all local and regional requirements for above ground tanks. Provide with rupture alarm and low level alarm.

M. Enclosure

1. Provide generator with standard weatherproof housing.

2.2 TRANSFER SWITCH EQUIPMENT

- A. Provide complete factory assembled transfer equipment with electronic controls designed for surge voltage isolation, and including voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts.
- B. Transfer Switch Ratings:
 1. Refer to the project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosures, and accessories.
- C. All transfer switches and accessories shall be UL listed and labeled, tested per UL Standard 1008, and CSA Approved.
- D. Main contacts shall be rated for 600 Volts AC minimum.

- E. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure, in ambient temperatures of -40 to +50 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
- F. Transfer switch equipment shall have a withstand and closing rating (WCR) in RMS symmetrical amperes greater than the available fault currents. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third-party listed and labeled for use with the specific protective device(s) installed in the application.
- G. Construction:
 - 1. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in both positions.
 - 2. Transfer switches rated through 1000 amperes shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms suitable for safe manual operation under load.
 - 3. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent interphase flashover. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
 - 4. Transfer switches designated on the drawings as 4-poles shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Equipment using add-on accessory overlapping contacts are not acceptable.
 - 5. Transfer switches which are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs, sized to carry 100% of the current designated on the switch rating.
 - 6. Enclosures shall be UL listed. The enclosure shall provide NEC wire bend space. The cabinet door shall be key-locking. Controls on cabinet door shall be key-operated.
 - 7. Transfer switches shall be mounted in NEMA '1' enclosures. The cabinet shall provide required wire bend space. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door.
- H. Automatic Controls:
 - 1. Transfer switches shall be provided with a fully automatic control system, and provisions for manual operation as described in this section.
 - 2. Control shall be solid-state and designed for a high level of immunity to power line surges and transients, demonstrated by test to IEEE Standard 587-1980. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs.
 - 3. Solid-state undervoltage sensors shall simultaneously monitor all phases of both sources. Pick-up and drop-out settings shall be adjustable. Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase. Voltage sensors shall have field calibration of actual supply voltage to nominal system voltage.
 - 4. Provide Phase Sequence Monitor and Balance module to protect against inadvertent phase rotation hookup and monitor for voltage phase imbalance between phases.
 - 5. The switch shall transfer when the emergency source reaches the set point voltage and frequency. Provide a solid-state time delay on transfer, adjustable from 0 to 120 seconds.

6. The switch shall retransfer the load to the normal source after a time delay retransfer, adjustable from 0 to 30 minutes. Retransfer time delay shall be immediately bypassed if the emergency power source fails.
 7. Controls shall signal the engine-generator set to stop after a time delay, adjustable from 0 to 10 minutes, beginning on return to the normal source.
 8. Power for transfer operation shall be from the source to which the load is being transferred.
 9. The control shall include latching diagnostic indicators to pinpoint the last successful step in the sequence of control functions, and to indicate the present status of the control functions in real time, as follows:
 - a. Source 1 OK
 - b. Start Gen Set
 - c. Source 2 OK
 - d. Transfer Timing
 - e. Transfer Complete
 - f. Retransfer Timing
 - g. Retransfer Complete
 - h. Timing for Stop
 10. The control shall include remote transfer inhibit and area protection features.
 11. Transfer switches shall be equipped with a field adjustable controls to allow the operator to control the transfer switch operating time during switching in both directions. The controls shall control the time the load is isolated from both power sources, to allow load residual voltage to decay before closure to the opposite source. The transfer switch operating speed control feature shall have an adjustable range of 0 to 7.5 seconds. Phase angle monitor is not acceptable substitute for this feature.
- I. Front Panel Devices:
1. Provide devices mounted on cabinet front consisting of:
 - a. A key-operated selector switch to provide the following positions and functions:
 - b. Test - Simulates normal power loss to control for testing of generator set. Controls shall provide for a test with or without load transfer.
 - c. Normal - Normal operating position.
 - d. Retransfer - Momentary position to override retransfer time delay and cause immediate return to normal source, if available.
- J. Battery Charger: Provide a float charge battery charger rated 10 amps. DC output voltage shall be as required for the starting batteries. An ammeter shall display charging current. The battery charger shall have fused AC input and fused DC output. Include fault indications and Form C contact for AC Fail, High Battery Voltage, and Low Battery Voltage.
- K. Manual Selector Switch: Provide a manual/automatic retransfer selector switch to provide either automatic retransfer after the retransfer time delay, or a manual retransfer when selected by an operator.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- D. Equipment shall be initially started and operated by representatives of the manufacturer.
- E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.2 FACTORY TESTS

- A. Equipment supplied shall be fully tested at the factory for function and performance.
- B. Factory testing may be witnessed by the owner. Supplier is responsible to provide two weeks notice for testing.
- C. Generator set factory tests on the equipment shall be performed at rated load and rated PF. Generator sets that have not been factory tested at rated PF will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.
- D. Transfer equipment factory tests: Each transfer switch supplied shall be factory tested before shipment. Factory tests shall include a complete functional test of the transfer switch controls, including calibration of the voltage sensors.
- E. **[optional section]**Test generator in accordance with NETA Standards for Rotating Machinery and Emergency Systems.

3.3 ON-SITE ACCEPTANCE TEST

- A. The complete installation shall be tested in accordance with Section 16040 following completion of all site work. Testing shall be conducted by representatives of the manufacturer. The owner shall be notified in advance and shall have the option to witness the tests.

3.4 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 10 persons. Training date shall be coordinated with the owner.

END OF SECTION 263213

SECTION 264314 - TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 WORK INCLUDED

- A. Transient Voltage Surge Suppression (TVSS) or Surge Protective Device (SPD) suitable for protection of electronic equipment and electrical systems 600 volts or less.
- B. Definition: The term Transient Voltage Surge Suppression (TVSS) describes the equipment called a Surge Protective Device (SPD) necessary for the protection of all AC electrical circuits and equipment from the affects of lightning induced voltages, external switching transients, and internally generated switching transients resulting from inductive and/or capacitive load switching.

1.3 REFERENCES

- A. Underwriters Laboratories, Inc. (UL) No. 1449 Rev. 2 Standard for Fire and Safety-TVSS
- B. Institute of Electrical and Electronics Engineers (IEEE) Std. 142-Recommended Practice for Grounding and Std. 518-Recommended Guide on Electrical Noise ANSI/IEEE C62.41-1991 Edition.
- C. Federal Information Processing Standards Publication 94 (FIPS PUB 94).

1.4 SUBMITTALS

- A. Submit product data under provisions of Division 1.
- B. Manufacturers' Product Data: Submit material specifications and installation data for products specified under Part 2.
- C. Performance Specification: The specification shall provide the minimum information as listed below.
 - 1. Electrical characteristics and ratings for each type of SPD.
 - 2. Drawings shall be provided indicating SPD's dimensions, weights, mounting provisions, and connection details to the power system.

3. Provide documentation of the SPD's UL 1449 listing. Any submittal without this documentation will be rejected.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Current Technology, Cutler Hammer/Westinghouse, General Electric, Liebert, Siemens, Square D or Tycor International.
- B. Substitutions: Under provisions of Division 1.

2.2 GENERAL

- A. The TVSS System as required, shall consist of a Service Protection Panel for each service rated 600 volts or less, and Branch Panel Protectors as indicated on the drawings.
- B. All devices shall operate as a total coordinated and engineered system, as well as being engineered as a system by the manufacturer.
- C. Maximum continuous operating voltages of any system component shall not be less than 115 percent of the nominal system operating voltage.
- D. All TVSS components shall be rated with an operating temperature range of 30 to 120 degrees Fahrenheit, and from 0 to 85 percent humidity noncondensing.
- E. TVSS components shall operate in altitudes up to 20,000 feet above sea level.
- F. No system component shall generate appreciable magnetic fields or sufficient fields to damage stored magnetic data.
- G. Average power consumption of any single TVSS system shall be 1 watt per phase or less with zero percent total harmonic distortion.
- H. Nominal system frequency is 60 Hertz; operating frequency range of the TVSS system shall be 0 to 400 Hertz.
- I. All SPD's shall be connected in parallel with the power system they are protecting. Series connected components shall not be used. Suppression paths shall not be ground.
- J. All SPD's shall be UL 1449 Rev 2 listed and bear the UL label.
- K. All SPD's shall be equipped with integral in line fusing.
- L. All SPD's shall bolt directly to the panelboard bussing or utilize a specialized cable designed to minimize voltage let-thru in the event of a surge.

2.3 MAIN SERVICE SPD

- A. The Main Service SPD enclosure shall be NEMA '1' construction, factory primed and painted.
- B. The Main Service SPD shall be installed parallel via a circuit breaker or fused switch rated for the interrupting current of the Main Switchboard or Panel, or the unit shall have 200K AIC internal fuses for direct bus bar mount.
- C. During normal suppression operation, the unit shall not short circuit or crowbar the power flow that would result in an interruption to the load.
- D. Unit shall not require interruption of building power for maintenance.
- E. Provide visual indication on the cover of the enclosure to indicate proper systems operation.
- F. Surge Current Capacity: Total surge current per phase (based on an 8 x 20 microsecond waveform) that the device is capable of surviving shall not be less than 250 kA per phase, or 125 kA per mode on L-G, L-N and N-G (WYE system); L-L and L-G (Delta system).
- G. The Main Service SPD shall be UL 1449 Rev 2 listed for Permanently Connected Products. The surge voltage rating (SVR) per UL 1449 Rev 2 shall be as follows for each service voltage:

<u>Voltage Configuration</u>	<u>UL (SVR) Level</u>
208Y/120 Volt, Three Phase	400 Vpk (L-N)

- H. ANSI/IEEE Category C3 Let Through Voltage: The let through voltage based on IEEE C62.41 and C62.45 recommended procedures for Category C3 surges (20 kV, 10 kA) shall be less than:

Modes	208Y/120	480Y/277
L-N	500V	900V

- I. ANSI/IEEE Category B3 Let Through Voltage: Let through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Category B3 ringwave (6 kV, 500 amps) shall be less than:

Modes	208Y/120	480Y/277
L-N	130V	200V

- J. Withstand: Each unit must be capable of surviving more than 3000 ANSI/IEEE C62.41 Category C transients without failure or degradation of UL 1449 Rev 2 SVR.
- K. The voltage protection level (clamping voltage) shall be provided for a 10x1000 microsecond waveform per ANSI/IEEE C62.41-1991 for B3 location categories using IEEE C62.45-1987 testing techniques (power applied). The voltage protection level (clamping voltage) shall not exceed the SVR rating provided in paragraph 2.3 G. above.
- L. The Service Panel TVSS shall be furnished with terminal connections capable of accepting up to #1/0 conductors.
- M. The transient suppression capability shall be equal bi-directionally and shall treat both the positive and negative impulses with separate suppressor modules per phase.

- N. Electrical Noise Filter: Each unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 50 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL 1283.
- O. Suppression shall be line to neutral, line to ground, and neutral to ground with the exception of a delta configuration which is line to line.

2.4 BRANCH PANEL SPD

- A. Where Branch Panel SPD's are installed in conjunction with a Main Service SPD, it shall operate as a totally coordinated engineered system. It shall achieve performance equal to or better than the UL 1449 Rev 2 rating of the source point unit.
- B. The Branch Panel SPD shall be listed to UL 1449 Rev 2.
- C. The suppression path shall not be ground.
- D. The unit shall not short circuit or crowbar the power flow that would result in an interruption to the load.
- E. Scheduled parts replacement or preventative maintenance shall not be required.
- F. The modules shall be bi-polar and bi-directional treating negative transients identically to positive transients with separate positive and negative suppression modules.
- G. The Branch Panel SPD enclosure shall be NEMA '1' construction, and be factory primed and painted.
- H. The SPD's shall be furnished with power on indication status (one per phase).
- I. Surge Current Capacity: Total surge current per phase (based on an 8 x 20 microsecond waveform) that the device is capable of surviving shall not be less than 120 kA per phase, or 60 kA per mode on L-G, L-N and N-G (Wye system); L-L and L-G (Delta system).
- J. The Branch Panel SPD shall be UL 1449 Rev 2 listed for Permanently Connected Products. The surge voltage rating (SVR) per UL 1449 shall be as follows for each service voltage:

<u>Voltage Configuration</u>	<u>UL (SVR) Level</u>
208Y/120 Volt, Three Phase	400 Vpk (L-N)

- K. ANSI/IEEE Category C3 Let Through Voltage: The let through voltage based on IEEE C62.41 and C62.45 recommended procedures for Category C3 surges (20 kV, 10 kA) shall be less than:

Modes	208Y/120	480Y/277
L-N	500V	900V

- L. ANSI/IEEE Category B3 Let Through Voltage: Let through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Category B3 ringwave (6 kV, 500 amps) shall be less than:

Modes	208Y/120	480Y/277
L-N	130V	200V

- M. Lifecycle: Each unit must be capable of surviving more than 2500 Category C transients without failure or degradation of UL 1449 clamp voltage.
- N. The Branch Panel SPD shall be integral with the panelboard and bolt directly to the panelboard bussing or utilize a specialized cable designed to minimize voltage let thru in the event of a surge.
- O. Electrical Noise Filter: Each unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 50 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL 1283.

PART 3 - EXECUTION

3.1 WARRANTY

- A. Warranty: The equipment shall be warranted against defects in material and/or workmanship for a minimum of five years.

3.2 INSTALLATION

- A. The installation shall comply with the manufacturers' printed instructions, and any national and local wiring codes.

3.3 IDENTIFICATION

- A. Refer to Electrical Identification, Section 16195, for identification requirements.

3.4 FIELD QUALITY CONTROL

- A. The TVSS System shall be installed in accordance with the manufacturers' printed instructions to maintain warranty.
- B. Upon completion of installation, the TVSS System shall not require testing of any kind.

END OF SECTION 264314

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces and recessed in canopies, lamps, ballasts, emergency lighting units, and accessories.
- B. Related Sections include the following:
 - 1. Section 260923 Lighting Control Devices.

1.3 SUBMITTALS

- A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features and accessories.
- B. Maintenance data for lighting fixtures.
- C. Emergency lighting units including battery and charger.

1.4 QUALITY ASSURANCE

- A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with the NEC.
- C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.
- D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, partition assemblies, and other construction.

1.6 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four years.
- B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: As indicated on the drawings.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- D. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
 - 1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
 - 2. Lens Thickness: 0.125 inch minimum, unless greater thickness is indicated.

2.3 FLUORESCENT LAMP BALLASTS

- A. General Requirements: Unless otherwise indicated, features include the following:
 - 1. Designed for type and quantity of lamps indicated at full light output.
 - 2. Total Harmonic Distortion Rating: Less than 10 percent.

3. Sound Rating: A.
 - B. Electronic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:
 1. Certified Ballast Manufacturer Certification: Indicated by label.
 2. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
 - C. Electromagnetic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:
 1. Type: Energy saving.
 2. Certified Ballast Manufacturer Certification: Indicated by label.
 - D. Ballasts for Compact Lamps: Electronic programmed start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
 1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: A.
 4. Total Harmonic Distortion Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.95 or higher, unless otherwise indicated.
 9. Power Factor: 0.95 or higher.
 10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 11. Ballast Case Temperature: 75 deg C, maximum.
 - F. Ballasts for Dimmer-Controlled Fixtures: Comply with general and fixture-related requirements above for electronic ballasts.
 1. Compatibility: Certified by manufacturer for use with specific dimming system indicated for use with each dimming ballast.
 - G. Ballasts for Low-Temperature Environments: As follows:
 1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
 2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
- 2.4 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS
- A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. Type: Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated.
 2. Operating Voltage: Match system voltage.
 3. Minimum Starting Temperature: Minus 22 deg F for single lamp ballasts.
 4. Normal Ambient Operating Temperature: 104 deg F.
 5. Open-circuit operation that will not reduce average life.
- B. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter-starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C
1. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).
 2. Open-circuit operation shall not reduce average lamp life..

2.5 EXIT SIGNS

- A. General Requirements: Comply with UL 924 and the following:
1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.
- B. Internally Lighted Signs: As follows:
1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.
- C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
1. Battery: Sealed, maintenance-free, nickel-cadmium type.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 6. Remote Test – Where indicated on the drawings: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 7. Integral Self-Test – Where indicated on the drawings: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 EMERGENCY LIGHTING UNITS

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate 1 fluorescent lamp continuously at an output of 1100 lumens for 90 minutes. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space. Provide integral to fixture or mounted adjacent to fixture.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 3. Battery: Sealed, maintenance-free, nickel-cadmium type.
 4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 5. Battery: Sealed, maintenance-free, nickel-cadmium type.
 6. Charger: Fully automatic, solid-state type with sealed transfer relay.
 7. Night-Light Connection: Where night-light option is called out in the drawings, operate one fluorescent lamp continuously.
- B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.
1. Emergency Connection: Operate 1 or 2 fluorescent lamps continuously at an output of 1100 lumens for 90 minutes. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Battery: Sealed, maintenance-free, nickel-cadmium type.
 3. Charger: Fully automatic, solid-state, constant-current type.
 4. Housing: NEMA 250, Type 1 enclosure.
 5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- C. Cold weather Compact Fluorescent: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, integral or remote mounted from lighting fixture. Comply with UL 924.
1. Emergency Connection: Operate 1 or two fluorescent lamps continuously at a minimum output of 1100 lumens for 90 minutes. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Battery: Sealed, maintenance-free, nickel-cadmium type.
 3. Charger: Fully automatic, solid-state, constant-current type.
 4. Housing: NEMA 250, Type 1 enclosure for remote-mounted.
 5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 7. Operating Temperature Range: -20° C to +55° C (-4° F to +131° F)
 8. Ballasts shall be equivalent to or exceed performance as follows:
 - a. Outdoor Compact Fluorescent Fixtures: Bodine B4CF1 or B4CF2
 - b. Outdoor Linear Fluorescent Fixtures: Bodine B50 Cold-Pak

2.7 LAMPS

- A. Fluorescent Color Temperature and Minimum Color-Rendering Index: 3500 K and 85 CRI, unless otherwise indicated.
- B. Non-compact fluorescent Lamp Life: Minimum rated average is 20,000 hours at 3 hours per start.
- C. Compact fluorescent Lamp Life: Minimum rated average is 12,000 hours at 3 hours per start.
- D. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3700 K and 65 CRI, unless otherwise indicated.
- E. Horizontally mounted Metal-Halide lamps shall be Venture Lamps series H-75 lamps.

2.8 FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: **1/2-inch** steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.
- B. Twin-Stem Hangers: Two, **1/2-inch** steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.
- C. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.
- D. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.
- F. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

2.9 FINISHES

- A. Fixtures: Manufacturer's standard, unless otherwise indicated.
 - 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
 - 2. Metallic Finish: Corrosion resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.
- B. Furnish and install a protective barrier around fixtures that are not insulation-contact-rated (non-IC-rated) in locations where insulation is installed. The protective barrier shall be installed to yield a 4" air-gap from the fixture on all sides and top.

- C. Support for Fixtures in or on Grid-Type Suspended Ceilings: Attach supports to building structure.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than **6 inches** from fixture corners.
 - 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- D. Suspended Fixture Support: As follows:
 - 1. Pendants and Rods: Where longer than **48 inches**, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings.

3.2 CONNECTIONS

- A. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Tests: As follows:
 - 1. Verify normal operation of each fixture after installation.
 - 2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
- C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
- D. Ballasts: Replace all noisy ballasts. Ballasts that can be heard shall be considered noisy. Repeat the procedure until a ballast is installed that is not noisy.

3.4 CLEANING AND ADJUSTING

- A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.
- B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 265100

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes exterior lighting units with luminaires, lamps, ballasts, poles/support structures, and accessories.
- B. Related Sections include the following:
 - 1. Section 260923 - Lighting Control Devices.
 - 2. Section 265100 - Interior Lighting for interior fixtures, lamps, ballasts, emergency lighting units, and accessories; and for exterior luminaires normally mounted on buildings.

1.3 DEFINITIONS

- A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.
- B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting unit indicated, arranged in order of lighting unit designation. Include data on features, accessories and finishes.
- B. Maintenance data for lighting units.

1.5 QUALITY ASSURANCE

- A. Luminaires and Accessories: Listed and labeled as defined in the NEC, Article 100, for their indicated use, location, and installation conditions by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with ANSI C2.
- C. Comply with the NEC.

1.6 DELIVERY, STORAGE, AND HANDLING OF POLES

- A. Retain factory-applied pole wrappings on metal poles until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: As indicated on the drawings.

2.2 LUMINAIRES

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- C. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit re-lamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange to disconnect ballast when door opens.
- E. Exposed Hardware Material: Stainless steel.
- F. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
- G. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.
- H. High-Intensity-Discharge Ballasts: Comply with ANSI C82.4. Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated.
 - 1. Ballast Fuses: One in each ungrounded supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
 - 2. Single-Lamp Ballasts: Minimum starting temperature of minus 40 deg C.
 - 3. Open-circuit operation will not reduce average life.
 - 4. High-Pressure Sodium Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90 deg C.
 - 5. Noise: Uniformly quiet operation, with a noise rating of B or better.

- I. Verify availability of space to install device at or close to ballast. Unit as specified is suitable for full 15-a branch-circuit protection. Coordinate with Drawings.
- J. Lamps: Comply with the standard of the ANSI C78 series that is applicable to each type of lamp. Provide luminaires with indicated lamps of designated type, characteristics, and wattage. Where a lamp is not indicated for a luminaire, provide medium wattage lamp recommended by manufacturer for luminaire.
 - 1. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3600 K and 70 CRI, unless otherwise indicated.

2.3 LUMINAIRE SUPPORT COMPONENTS

- A. Description: Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.
- B. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 80 mph with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.
- C. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.
- D. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Will not cause galvanic action at contact points.
 - 2. Mountings: Correctly position luminaire to provide indicated light distribution.
 - 3. Anchor Bolts, Nuts, and Washers: Hot-dip galvanized after fabrication unless stainless-steel items are indicated.
 - 4. Anchor-Bolt Template: Steel.
- E. Pole/Support Structure Bases: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.
- F. Steel Poles: Tubing complying with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in length with access handhole in pole wall.
- G. Steel Mast Arms: Fabricated from NPS 2 black steel pipe, continuously welded to pole attachment plate with span and rise as indicated.
- H. Metal Pole Brackets: Match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate luminaire.
- I. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- J. Concrete for Pole Foundations: Comply with Division 3.

2.4 FINISHES

- A. Steel: Grind welds and polish surfaces to a smooth, even finish.
 - 1. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A 123.
 - 2. Surface Preparation: Clean surfaces to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel.
 - 3. Interior: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.
 - 4. Polyurethane Enamel: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Concrete Foundations: Construct according to Division 3.
- B. Install poles as follows:
 - 1. Use web fabric slings (not chain or cable) to raise and set poles.
 - 2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 3. Secure poles level, plumb, and square.
 - 4. Grout void between pole base and foundation. Use non-shrinking or expanding concrete grout firmly packed in entire void space.
 - 5. Use a short piece of ~~1/2-inch~~ diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- C. Luminaire Attachment: Fasten to indicated structural supports.
- D. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 CONNECTIONS

- A. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.
- B. Ground metal poles/support structures.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed unit for damage. Replace damaged units.

3.4 CLEANING AND ADJUSTING

- A. Clean units after installation. Use methods and materials recommended by manufacturer.

END OF SECTION 265600

SECTION 271101 – TELECOM RACEWAY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes telecom raceway systems.

1.3 RELATED WORK

- A. Section 260533 – Raceways and Boxes.
- B. Section 260536 – Cable Trays.

1.4 SYSTEM DESCRIPTION

- A. Conduit, cable trays and boxes to form an empty raceway system.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Conduit: Refer to Section 260533.
- B. Cable trays: Refer to Section 260536.
- C. Outlet, pull or junction boxes: Refer to Section 260533.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide pullboxes in telecom conduit runs spaced less than 100 feet apart, and on the backboard side of runs with more than two right angle bends.
- B. Place telecom label on pull and junction boxes.

- C. Provide pullwire in each telecom conduit run.

END OF SECTION 271101

SECTION 275116 - PUBLIC ADDRESS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes equipment for public address and sound systems.

1.3 DEFINITIONS

- A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
- B. Zone: A separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 PERFORMANCE REQUIREMENTS

- A. System Functions: Include the following:
 - 1. Selectively connecting separate zones to different signal channels.
 - 2. Amplifying sound from microphone outlets in central room.
 - 3. Communicating simultaneously to all zones regardless of zone or channel switch settings.
 - 4. Paging.
 - 5. Producing a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
 - 6. Reproducing high-quality sound that is free from noise and distortion at all loudspeakers at all times during equipment operation, including standby mode with inputs off; and output free from non-uniform coverage of amplified sound.

1.5 SUBMITTALS

- A. Product Data: For each type of equipment.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection. Include control panel layouts and wiring diagrams.
- C. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this section.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- C. Comply with the NEC.
- D. Comply with UL 50.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: As indicated on the drawings.

2.2 EQUIPMENT

- A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Equipment: Modular type, using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
- C. Waterproof Equipment: Listed and labeled for duty outdoors or in damp locations.

2.3 PREAMPLIFIERS

- A. Comply with EIA SE-101-A; either separately mounted or as an integral part of power amplifier.
- B. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.
- C. Total Harmonic Distortion: Less than 1 percent.
- D. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.
- E. Input Jacks: Minimum of two. One matched for low-impedance microphone; the other matchable to cassette deck, CD player, or radio tuner signals without external adapters.
- F. Minimum Noise Level: Minus 55 dB below rated output.
- G. Controls: On/off, input levels, and master gain.

2.4 POWER AMPLIFIERS

- A. Comply with EIA SE-101-A.
- B. Mounting: Rack mounted.
- C. Output Power: 70-W balanced line.
- D. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.
- E. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
- F. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.
- G. Output Regulation: Less than 2 dB from full to no load.
- H. Controls: On/off, input levels, and low-cut filter.
- I. Input Sensitivity: Matched to preamplifier and providing full-rated output with a sound-pressure level of less than 10 dynes/sq. cm impinging on a speaker microphone or handset transmitter.

2.5 COMPONENTS

- A. Microphone: Comply with EIA SE-105.
 - 1. Type: Dynamic, with cardioid polar or omni-directional characteristic.
 - 2. Impedance: 150 ohms.
 - 3. Frequency Response: Uniform, 60 to 12,000 Hz.
 - 4. Output Level: Minus 58 dB minimum.
- B. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.
 - 1. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.
 - 2. Signal Reduction Ratio: At least a 10:1 and 5:1 selectable capability.
 - 3. Distortion: 1 percent, maximum.
 - 4. Rated Output: Minimum of plus 14 dB.
- C. Control Console: Modular, desktop cabinet; complying with EIA-310.
 - 1. Housing: Steel, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.
 - 2. Controls: Include the following:
 - a. Switching devices to select signal sources for distribution channels.
 - b. Program selector switch to select source for each program channel.
 - c. Switching devices to select zones for paging.
 - d. All-call selector switch.
 - 3. Indicators: A visual annunciation for each distribution channel to indicate source being used.
 - 4. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.

5. Spare Positions: 20 percent spare zone control and annunciation positions on console.
 6. Microphone jack.
- D. Equipment Rack: Comply with EIA-310-D. House amplifiers and auxiliary equipment in standard EIA 19-inch racks.
1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically.
 2. Power-Supply Connections: Approved plugs and receptacles.
 3. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
 4. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
 5. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
 6. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
 7. Power-Control Panel: On front of equipment housing, with a master power on/off switch and pilot light, and socket for a 5-A, indicating, cartridge fuse for rack equipment power.
 8. Service Light: At top rear of rack and control by an adjacent switch.
 9. Vertical Plug Strip: Grounded receptacles, 12 inches on center the full height of rack, to supply rack-mounted equipment.
 10. Maintenance Receptacles: Duplex convenience outlets supplied independent of equipment plug strip and located in front and bottom rear of rack.
 11. Spare Capacity: 20 percent spare space capacity in rack for future equipment.
- E. Cone-Type Loudspeakers: Comply with EIA SE-103.
1. Minimum Axial Sensitivity: EIA pressure rating of 45 dB.
 2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
 3. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
 4. Minimum Dispersion Angle: 100 degrees.
 5. Rated Output Level: 10 W.
 6. Matching Transformer: Comply with EIA-160. Full-power rated with four EIA standard taps. Maximum insertion loss of 0.5 dB.
 7. Flush-Ceiling Mounting Units: In steel back boxes, acoustically dampened. Metal ceiling grille with baked, white-enamel finish.
- F. Microphone Outlets: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with a brushed stainless-steel device plate.
- G. Cable and Conductors: Jacketed, twisted-pair and twisted-multipair, untinned, solid-copper conductors.
1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
 2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch thick over shield with filled interstices. Shield No. 34 AWG tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment to comply with manufacturer's written instructions.
- B. Wiring Method: Install wiring in raceway except within consoles, desks, and counters. Conceal cable and raceway except in unfinished spaces.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.
- D. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.
- E. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least **12 inches** for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
- F. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- G. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- H. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables to identify media in coordination with system wiring diagrams.
- I. Wall-Mounting Outlets: Flush mounted.
- J. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
- K. Weatherproof Equipment: Install units that are mounted outdoors, in damp locations, or where exposed to weather consistent with requirements of weatherproof rating.
- L. Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

3.2 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.3 FIELD QUALITY CONTROL

- A. Operational Test: Perform tests that include originating program and page material at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and freedom from noise and distortion. Correct deficiencies and retest, if required.
- B. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain equipment.
 - 1. Train owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining equipment.
 - 2. Review data in maintenance manuals.

END OF SECTION 275116

SECTION 16851 - FIRE ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes fire alarm systems.
- B. Related Sections include the following:
 - 1. Division 8 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.3 DEFINITIONS

- A. FACP: Fire alarm control panel.
- B. LED: Light-emitting diode.
- C. NICET: National Institute for Certification in Engineering Technologies.
- D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

- A. Noncoded, addressable system; multiplexed signal transmission dedicated to fire alarm service only.
- B. Noncoded, analog-addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only.

1.5 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 72.
- B. Premises protection includes Type 5B Fully Sprinkled and Type E Occupancy.
- C. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Flame detectors.
4. Smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.
7. Fire extinguishing system operation.
8. Fire standpipe system.

D. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Unlock electric door locks in designated egress paths.
6. Release fire and smoke doors held open by magnetic door holders.
7. Activate voice/alarm communication system.
8. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
9. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
10. Record events in the system memory.
11. Record events by the system printer.

E. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper.
2. Operation of any duct detectors or induct detectors.

F. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

G. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event on system printer.

1.6 SUBMITTALS

Prior to the start of work, the contractor shall provide a complete and comprehensive submittal for review by the engineer. These are to describe the proposed system and its equipment. Failure to provide a complete submittal shall be grounds for summary rejection of any incomplete submittal documentation. Contractor's who provide re-submittal's, due to prior rejection shall be subject to a re-review fee, should the Engineer elect to do so. The complete submittal shall include, but not be limited to, all of the following material:

A. Power Calculations

1. Battery capacity calculations shall be a minimum of 125% of the calculated requirement.
2. Supervisory power requirements for all equipment.
3. Alarm power requirements for all equipment.
4. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst case condition plus 25% spare capacity.
5. Voltage-drop calculations for wiring runs demonstrating worst case condition.

B. Complete manufacturers catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

C. Complete drawings covering the following shall be submitted by the contractor for the proposed system. Floor plans in a CAD compatible format showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used. Floor plans will be prepared at 1/8" scale.

D. A complete proposed system database including a description of all logic strings, control by event programming and point identification labels on a 3.5" high density floppy disk and in a formatted printed form, as required for off-site editing, shall be submitted for evaluation by the owner.

1. The program shall include all required interactive control functions between the local network systems and the methods for implementing these actions.

E. Provide the address, telephone number, and contact person(s) of the manufacturer's local service facility for normal and off-hour warranty issues.

F. If the fire alarm system and its equipment are supplied by a manufacturer's distributor, as part of the submittal documentation, the manufacturer shall provide, on its corporate letterhead, a "letter of support". Said "letter of support" shall state that, when in the opinion of the Engineer, the distributor's efforts require back-up and/or assistance, the manufacturer shall provide, at no cost to the Owner, all required technical support during the installation phase and for a one (1) year guarantee period starting on the date of final acceptance by the owner and the authority having jurisdiction. If said "letter of support" is not submitted, the manufacturer's equipment will be deemed unacceptable and shall be grounds for summary rejection.

G. Provide a fire alarm system function matrix. Matrix shall illustrate alarm output events in association with initiating devices input events. Matrix shall represent a summary of the installed system alarm, supervisory and trouble functions. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at the time of bid. Failure to provide this requirement shall be cause for summary rejection of submittal

documents where additional departures are discovered. (See Appendix-A NFPA-72 for minimum matrix requirements - A.10.6.2.3(9) 2002.

- H. For each system control panel and/or transponder panel, provide panel ampere loading during both normal and alarm modes, with time calculations to substantiate compliance with battery back-up power requirements (battery Ampere-Hour capacity), described elsewhere in these specifications.
- I. For each system control panel and/or transponder panel, provide written schedule of active and spare addresses provided on each addressable circuit to substantiate compliance with circuit usage/spare requirements, described elsewhere in these specifications.
- J. For each system control panel and system transponder notification appliance circuit provide a written schedule of spare capability in amperes available for future possible use.
- K. Provide manufacture's printed product data, catalog pages and descriptions of any special installation requirements and/or procedures. Drawings depicting any special physical installation requirements shall show physical plans, elevations, all dimensions, conduit entry, minimum access clearances and any other details required.
- L. Provide shop drawings as follows:
 - 1. Drawing or catalog page showing actual dimensions of the main FCS.
 - 2. Drawing(s) or catalog page(s) showing actual dimensions of any additional system control panels, amplifier cabinets and/or battery cabinets.
 - 3. Drawing or catalog page showing actual dimensions of the remote annunciator(s).
 - 4. Single line riser diagram showing, all equipment, all connections and number and size of all conductors and conduits.
 - 5. Provide samples of various items when so requested by the architect/engineer.
- M. The fire protection contractor shall provide copies of certification for service technician's formal training by the system manufacture. As a minimum, certification documents shall indicate training dates, systems qualified, name of individual certified and current status.
- N. Product Data: For each type of product indicated within 90 days of notice to proceed.
- O. Within 90 days of notice to proceed, the contractor shall submit a programming printout and digital copy of the program to the Engineer for review.
- P. Qualification Data: For Installer: NICE ET Level II certification within 60 days of notice to proceed.
- Q. Field quality-control test reports: provide test reports 10 days prior to final test requirements.
- R. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.
- S. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
 - a. Hard copies on paper to Owner, Architect, and authorities having jurisdiction.
 - b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level II.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. 30 days after award of bid, the contractor shall conduct a meeting with the owner; owners representative, the Engineer and the architect to discuss compliance of the specifications and drawings.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
 3. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
 4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
 5. Keys and Tools: One extra set for access to locked and tamper proofed components.
 6. Audible and Visual Notification Appliances: One of each type installed.
 7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. FACP and Equipment:
 - a. Silent Knight; a GE-Honeywell Company 5820 XL Series.
 - 2. Wire and Cable:
 - a. Comtran Corporation.
 - b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
 - c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
 - d. West Penn Wire/CDT; a division of Cable Design Technologies.
 - 3. Audible and Visual Signals:
 - a. Gentex

2.2 FACP

- A. General Description:
 - 1. Modular, power-limited design with electronic modules, UL 864 listed.
 - 2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 - 3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. Circuits:
 - 1. Signaling Line Circuits: NFPA 72, Class B, Style 3.
 - a. System Layout: Each signaling line circuit shall be loaded no more than 80% capacity.
 - 2. Notification-Appliance Circuits: NFPA 72, Class A, Style Z.
 - 3. Notification-Appliance Circuits: NFPA 72, Class B, Style W.

4. Actuation of alarm notification appliances, annunciation, smoke control, shall occur within 10 seconds after the activation of an initiating device.
 5. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.
- D. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
 2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
 3. Sound general alarm if the alarm is verified.
 4. Cancel FACP indication and system reset if the alarm is not verified.
- E. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.
- F. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.
- G. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.
1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- H. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.
- I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.
1. Notification-Appliance Circuits: NFPA 72, Class B.
- J. Service Modem: Ports shall be RS-232 for system printer and for connection to a dial-in terminal unit.

1. The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.
- K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory signal supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.
 1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
 2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."
- L. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
 1. Batteries: Vented, wet-cell pocket, plate nickel cadmium.
 2. Battery and Charger Capacity: Comply with NFPA 72.
- M. Surge Protection:
 1. Install surge protection on normal ac power for the FACP and its accessories. Comply with Division 16 Section "Transient Voltage Suppression" for auxiliary panel suppressors.
 2. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.
- N. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 MANUAL FIRE ALARM BOXES

- A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.
 1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
 2. Station Reset: Key- or wrench-operated switch.
 3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

2.4 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Multipurpose type, containing the following:
 - a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - b. Heat sensor, combination rate-of-rise and fixed temperature.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
7. Where noted on drawings provide a welded wire screen protective cover.
8. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
 - a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg F (8 or 11 deg C) per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 135 or 155 deg F (57 or 68 deg C).
 - c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:
 - a. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for

mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

- a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.
5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating status. Provide remote status and alarm indicator and test station where indicated.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
8. Each sensor shall have multiple levels of detection sensitivity.
9. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
10. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.5 NOTIFICATION APPLIANCES

- A. Description: Equipped for mounting as indicated and with screw terminals for system connections.
 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
 2. Where called for on plans to have a wire guard, provide and install a welded wire screen guard of appropriate size. Polycarbonate or other transparent protective covers are prohibited.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn.
- C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 1. Rated Light Output: as indicated.
 2. Strobe Leads: Factory connected to screw terminals.
 3. Where called for on plans to have a wire guard, provide and install a welded wire screen guard of appropriate size. Polycarbonate or other transparent protective covers are prohibited.

2.6 SPRINKLER SYSTEM REMOTE INDICATORS

- A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the

indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.7 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.
 - 1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
 - 2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
 - 3. Rating: 24-V dc.
- B. Material and Finish: Match door hardware.

2.8 REMOTE ANNUNCIATOR

- A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Class 1.
- B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LED's permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.9 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall where indicated to a circuit-breaker shunt trip for power shutdown and to release doors.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Listed and labeled according to UL 632.
- B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

- C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.
- D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.11 GUARDS FOR PHYSICAL PROTECTION

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 - 1. Factory fabricated and furnished by manufacturer of the device.
 - 2. Finish: Paint of color to match the protected device.

2.12 WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG size as recommended by system manufacturer.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Line-Voltage Circuits: No. 12 AWG, minimum.
- D. All wire and cable shall be installed in conduit.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Smoke or Heat Detector Spacing:
 - 1. Smooth ceiling spacing shall not exceed [30 feet (9 m)] .
 - 2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
 - 3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.
- B. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.

- C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.
- D. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- E. Audible Alarm-Indicating Devices: Install between 80" and 96" above finished floor or on ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- F. Visible Alarm-Indicating Devices: Install intergal to each alarm horn.
- G. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- H. FACP: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
- I. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.2 WIRING INSTALLATION

- A. Install wiring according to the following:
 - 1. NECA 1.
 - 2. TIA/EIA 568-A.
- B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."
 - 1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:
 - 1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
 - 2. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, is not permitted.
 - 3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.
- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 16 Section "Electrical Identification."
- B. Install instructions frame in a location visible from the FACP.
- C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

- A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to witness field tests and inspections and prepare test reports. Contact Green Fire Protection two weeks prior to test. The contractor shall provide all personnel for this test with Green Fire Protection to witness. There shall be two tests, one prior to the Fire Marshall test and one with the Fire Marshall.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
 - 2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct witness of Green Fire Protection.

3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
 4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
 - a. Detectors that are outside their marked sensitivity range shall be replaced.
 5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.
 6. Contact Green Fire Protection to inspect conduit rough in, witness cable testing, and to visually inspect cable terminations prior to cover.
- D. At no time shall the contractor make changes to the documents without written permission from the Engineer.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 283100

SECTION 310120 - TRAFFIC CONTROL REQUIREMENTS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. In accordance with Manual on Uniform Traffic Control Devices for Highways, prepared by the National Joint Committee of Uniform Traffic Control Devices or as per local governing authority.

PART 2 - PRODUCTS - N/A

PART 3 - EXECUTION

3.01 TRAFFIC CONTROL

- A. A construction and traffic control schedule indicating areas and type of work to be performed shall be submitted by the Contractor for review by the Architect prior to starting work on the Project. This schedule shall include proposed detours and any necessary traffic control devices and pavement markings.
 - 1. All traffic control plans shall be in conformance with the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways and the Transportation Department's Standard Details
- B. A minimum of two working days notice shall be given before any changes in the schedule is made.
- C. The Contractor shall provide an individual or individuals trained in traffic control to maintain and monitor required traffic control. Such individual or individuals shall have traffic control as a primary responsibility and duty and shall be available at all times that work is in progress to perform these duties. The Contractor is responsible for monitoring and maintaining traffic control devices during non-working days and non working hours. During non-working days the individual shall visit the site at least once per day and perform maintenance of traffic control devices as necessary. The individual responsible need not be on duty but shall be on call during the construction phase and be available by telephone contact to correct problems and perform maintenance.
- D. Detours. Detours, such as utilization of one or more traffic lanes for construction or maintenance shall be the responsibility of the Contractor. Costs for these items shall be included in the contract price. A detour plan showing the detour route and all applicable detour signing shall be furnished by the Contractor and approved by the governing authority before starting work on the project. Both lanes of traffic shall be open with appropriate construction signing during all non-working hours.
- E. Local and Emergency Traffic. Pedestrian traffic shall be provided access to private properties at all times, except during urgent stages of construction when it is impracticable to carry on the construction and maintain traffic simultaneously.
- F. No private driveway may be closed without the approval of the governing authority. No private driveways may be closed for more than eight (8) hours without written approval of the property owner.
- G. Emergency traffic such as police, fire, school bus, mail delivery and disaster units shall be provided reasonable access at all times. The Contractor shall be liable for any damages which may result from his failure to provide such reasonable access.
- H. The Contractor shall keep emergency vehicle dispatchers up-to-date on road detours and closures at all times.
- I. Protection of Pedestrian and Vehicular Traffic. The Contractor shall take every precaution to protect pedestrian and vehicular traffic. Wherever, in the opinion of the Architect/governing authority, the Contractor has not provided sufficient or proper safety precautions and safeguards, he shall do so immediately and to the extent deemed advisable.

- J. The posting of advance warning signs, barricades, traffic cones, flashers, etc., shall be in accordance with the current edition of Part VI of the "Manual on Uniform Traffic Control Devices for Streets and Highways" prepared by the National Joint Committee of Uniform Traffic Control Devices.
- K. Flagmen. The Contractor shall furnish, at his own expense, all flag persons who may be needed.
- L. Dust Control. It shall be the Contractor's responsibility to control dust on the project and on any detour by watering as directed by the Architect. Dust control on the project or on a detour shall be considered incidental to the project. Also see Division 1 requirements.
- M. Traffic Control Within and Abutting the Project. The Contractor shall place and maintain all signs, barricades and warning lights within the limits of the project on the approach to the work area so that approaching traffic will be aware of construction. Signs which are required shall be furnished by the Contractor.
- N. Barricades shall be furnished by the Contractor. The barricades shall be of a conventional design normally used in road construction work and painted "construction orange" with black stripes.
- O. Traffic Control Signs. Standard traffic control signs required for construction will be furnished by the Contractor. He shall maintain them in a neat condition until the need for them has ceased, after which he shall carefully remove the signs.

END OF SECTION 310120

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.
- D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than **2 inches** in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.
- G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or videotape.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1.

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.
- D. Utility Locator Service: Notify utility locator service Call Before You Dig for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.
- J. Dust Control: Water sprinkling shall be used to control release of dust during clearing and grubbing.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."
1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
- B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.
1. Use coating with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.
- C. Protect existing site improvements to remain from damage during construction.
1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.

3.4 UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies to shut off indicated utilities.
 - 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- B. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- D. Excavate for and remove underground utilities indicated to be removed.
- E. Removal of underground utilities is included in Division 26 and Division 33 Sections.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees indicated to remain.

2. Grind down stumps and remove roots, obstructions, and debris to a depth of **18 inches** below exposed subgrade and final finish grade whichever is greater.
 3. Use only hand methods for grubbing within protection zones.
 4. Chip removed tree branches and stockpile in areas approved by Architect.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding a loose depth of **8 inches**, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered (approximately **12 inches**) in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects more than **2 inches** in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
1. Limit height of topsoil stockpiles to **72 inches**.
 2. Do not stockpile topsoil within tree protection zones.
 3. Dispose of surplus topsoil onsite as indicated or directed. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
 4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove fence posts/ footings, slabs, paving, curbs, gutters, and aggregate base as indicated.
1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 2. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - a. Place fill material in horizontal layers not exceeding a loose depth of **8 inches**, and compact each layer to a density equal to adjacent original ground or required improvements to be installed over removed improvements.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. References
 1. AASHTO M147-65 - Materials for Aggregate and Soil-Aggregate.
 2. AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop
 3. ASTM C 136 –Method for Sieve Analysis of Fine and Course Aggregates.
 4. ASTM D 698 - Test Methods for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures using 5.5 lb Rammer and 12 inch Drop.
 5. ASTM C 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 6. ASTM D 3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
 7. ASTM D 1557 – Test Methods for Moisture- Density Relations of Soil and Soil-Aggregate Mixtures using 10 lbs (4.54 kg) Rammer and 18” (457 mm) Drop.
 8. **Geotechnical Engineering Report of Boise Fire Station No. 8, File BO15259A.**
 9. **ISPWC – Idaho Standards for Public Works Construction, current edition.**
 10. **Ada County Highway District Supplemental Specifications, current edition.**

1.2 SUMMARY

- A. Section Includes:
 1. Preparing subgrades for slabs-on-grade walks pavements turf and grasses and plants.
 2. Excavating and backfilling for buildings and structures.
 3. Drainage course for concrete slabs-on-grade.
 4. Subbase course for concrete walks and pavements.
 5. Subbase course and base course for asphalt paving.
 6. Subsurface drainage backfill for walls and trenches.
 7. Excavating and backfilling trenches for utilities and pits for buried utility structures.
- B. Related Sections:
 1. Division 01 Section "Construction Progress Documentation Photographic Documentation" for recording preexcavation and earth moving progress.
 2. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
 3. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.

4. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
5. Division 32 Section "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
6. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
 2. Bulk Excavation: Excavation more than **10 feet** in width and more than **30 feet** in length.
 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Landscape Architect. Unauthorized excavation, as well as remedial work directed by Landscape Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

- K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 - 1. Controlled low-strength material, including design mixture.
 - 2. Warning tapes.
- B. Samples for Verification: For the following products, in sizes indicated below:
 - 1. Warning Tape: **12 inches** long; of each color.
- C. Qualification Data: For qualified testing agency.
- D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 - 1. Classification according to ASTM D 2487.
 - 2. Laboratory compaction curve according to ASTM D 698 ASTM D 1557.
- E. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.
- F. Contractor shall submit a detailed materials stockpile plan to the architect's representative and the owner for approval prior to any earthwork operations.

1.5 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
- B. Preexcavation Conference: Conduct conference at Project site to comply with requirements in Division 1.
- C. Aggregates: **Idaho Standards for Public Works Construction, current edition.**
- D. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
- E. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- F. All gravel, subbase, and other imported fill materials other than topsoil shall only be stockpiled in proposed impervious areas. No gravel or rock materials shall be stock piled or temporarily

placed in proposed landscape or swale basin areas in order to prevent landscape contamination with rock materials.

1.6 PROJECT CONDITIONS

- A. Verify survey benchmark and intended elevations for the work are as indicated.
- B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- C. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- D. Utility Locator Service: Notify utility locator service "Call Before You Dig" for area where Project is located before beginning earth moving operations.
- E. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01.
- F. Do not commence earth moving operations until plant-protection measures specified on drawings are in place.
- G. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- H. Do not direct vehicle or equipment exhaust towards protection zones.
- I. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, ML, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than **3 inches** in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel or stone consisting of 6-inch minus select, clean, granular soil with no more than 50 percent oversize (greater than 3/4-inch) material and no more than 12 percent fines (passing No. 200 sieve), except that the maximum material diameter is no more than 2/3 the component thickness. These fill materials should be placed in layers not to exceed 12 inches in loose thickness and must be compacted a minimum of 95 percent of the maximum dry density as determined by ASTM D 698. Material must be moisture conditioned to achieve optimum moisture content prior to compaction.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a **1-1/2-inch** sieve and not more than 8 percent passing a **No. 200** sieve. Material must comply with **ITD Standard Specifications for Highway construction sections 303 and 703** for aggregates.
- F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a **1-inch** sieve and not more than 8 percent passing a **No. 200** sieve.
- G. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a **1-1/2-inch** sieve and 0 to 5 percent passing a **No. 8** sieve.
- H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a **1-inch** sieve and 0 to 5 percent passing a **No. 4** sieve.
- I. Sand: ASTM C 33; fine aggregate.
- J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches** wide and **4 mils** thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to **30 inches** deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.4 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus **1 inch**. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings, Foundations, and Slab on Grade: Excavated under footings and slab on grade and within **12 inches** of bottom of footings, place 12-inches of structural fill base course in 8-inch lifts, provide compaction testing. Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus **1 inch**. Do not disturb bottom of excavations intended as bearing surfaces.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 - 1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Cut and protect roots according to requirements in Division 01 and as shown on drawings.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to **12 inches** higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: **12 inches** each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. For pipes and conduit less than **6 inches** in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

2. For pipes and conduit **6 inches** or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
 3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
 4. Excavate trenches **6 inches** deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trench Bottoms: Excavate trenches **4 inches** deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
1. Excavate trenches **6 inches** deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- E. Trenches in Tree- and Plant-Protection Zones:
1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
 3. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.7 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than **15 tons** to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to **3 mph**.
 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of **2500 psi**, may be used when approved by Architect.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring and bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within **12 inches** of bottom of footings with structural fill soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."
- D. Backfill voids with satisfactory soil while removing shoring and bracing.

- E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.
- G. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- H. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.
- I. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.
 - 3. Under steps and ramps, use engineered fill.
 - 4. Under building slabs, use engineered fill.
 - 5. Under footings and foundations, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than **8 inches** in loose depth for material compacted by heavy compaction equipment, and not more than **4 inches** in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 and ASTM D 1557:
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top **12 inches** of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways, scarify and recompact top **6 inches** below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 - 3. Under turf or unpaved areas, scarify and recompact top **6 inches** below subgrade and compact each layer of backfill or fill soil material at 85 percent.
 - 4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.15 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Turf or Unpaved Areas: Plus or minus **1 inch**.
 - 2. Walks: Plus or minus **1 inch**.
 - 3. Pavements: Plus or minus **1/2 inch**.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of **1/2 inch** when tested with a **10-foot** straightedge.

3.16 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
 - 1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.

2. Place base course material over subbase course under hot-mix asphalt pavement.
 3. Shape subbase course and base course to required crown elevations and cross-slope grades.
 4. Place subbase course and base course **6 inches** or less in compacted thickness in a single layer.
 5. Place subbase course and base course that exceeds **6 inches** in compacted thickness in layers of equal thickness, with no compacted layer more than **6 inches** thick or less than **3 inches** thick.
 6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698 and ASTM D 1557.
- C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least **12 inches** wide or per plans, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698 and ASTM D 1557.

3.17 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 2. Determine that fill material and maximum lift thickness comply with requirements.
 3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every **2000 sq. ft.** or less of paved area or building slab, but in no case fewer than three tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every **100 feet** or less of wall length, but no fewer than two tests.

3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus unsatisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
- B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Landscape Architect.
 1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

- A. The Asphalt Institute - Manual MS-4 - The Asphalt Handbook.
- B. The Asphalt Institute - Manual MS-13 - Asphalt Surface Treatments for Asphalt Penetration Macadam.
- C. ASTM D 692 - Specification for Course Aggregate for Bituminous Paving Mixtures.
- D. ASTM D 946 - Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
- E. ASTM D 1073 - Fine Aggregates for Bituminous Paving Mixtures.
- F. ASTM D 3381 - Specification for Viscosity-Graded Asphalt Cement for use in Pavement Construction.
- G. ASTM D 3515 - Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
- H. ISPWC - Section 800 - Aggregate/Asphalt Idaho Standard Public Works Construction, current edition.
- I. ASTM D 1557 – Test Methods for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures using 10 lbs (4.54 kg) Rammer and 18” (457 mm) Drop.
- J. City of Boise and Ada County Highway District Supplemental Specifications.**
- K. Geotechnical Engineering Report of Boise Fire Station No. 8, File BO15259A**

1.3 SUMMARY

- A. Section Includes:
 - 1. Hot-mix asphalt patching.
 - 2. Hot-mix asphalt paving.
 - 3. Hot-mix asphalt paving overlay.
 - 4. Asphalt surface treatments.
 - 5. Pavement-marking paint.
 - 6. Wheel Stops

- B. Related Sections:
 - 1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
 - 2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

1.4 DEFINITION

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.
- B. **ISPWC: Idaho Standards for Public Works Construction.**

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
 - 1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
 - 2. Job-Mix Designs: For each job mix proposed for the Work.
- B. Samples: For each paving fabric, 12 by 12 inches minimum.
- C. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
 - 1. Each paving fabric, 12 by 12 inches minimum.
- D. Qualification Data: For qualified manufacturer and Installer.
- E. Material Certificates: For each paving material, from manufacturer.
- F. Material Test Reports: For each paving material.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction and the Idaho Standards for Public Works Construction . Engage a firm experienced in manufacturing hot-mix asphalt paving material similar to that indicated for this project with a five-year record of successful in-service performance.
- B. Installer Qualifications: Asphalt manufacturer's authorized installer who is trained and approved for installation of asphalt required for this Project. Engage an experienced installer who has completed hot-mix asphalt paving similar in material similar to that indicated for this project with a five-year record of successful in-service performance.
- C. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

- D. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Idaho Standards for Public Works Construction, **City of Boise** supplemental specifications, and **Ada County Highway District** supplemental specifications for work within the right-of-way. Comply with ASTM D 3515.
- E. Obtain materials from same source throughout.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Prime Coat: Minimum surface temperature of 60 deg F.
 - 2. Tack Coat: Minimum surface temperature of 60 deg F.
 - 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
 - 4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
 - 6. Wind less than 10 per hour.
 - 7. Do not place during rainfall, sand or dust storms, or before any imminent storms that might damage the construction.
 - 8. Place bitumen mixture when temperature is not more than 15 F degrees below bitumen supplier's bill of lading and not more than maximum specified temperature.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

- C. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
 - 1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.
- D. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 58-28.
- B. Asphalt Cement: ASTM D 3381 for viscosity-graded material ASTM D 946 for penetration-graded material.
- C. Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-250.
- D. Prime Coat: Asphalt emulsion prime coat complying with Idaho Standards for Public Work Construction requirements.
- E. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- F. Water: Potable.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.
- C. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
- D. Joint Sealant: ASTM D 6690 or AASHTO M 324, hot-applied, single-component, polymer-modified bituminous sealant.
- E. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
 - 1. Color: White Yellow Blue As indicated on plans.
- F. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 3/4-inch diameter, 16-inch minimum length.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Provide mixes complying with composition, grading, and tolerance requirements in ASTM D 3515 for the following nominal, maximum aggregate sizes:
 - a. Surface Course: 1/2 inch.
- B. Emulsified-Asphalt Slurry: ASTM D 3910, Type 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Geotechnical Engineer, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.
- D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompress existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseal concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseal pieces firmly.
 2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..
1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.
- E. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
1. Clean cracks and joints in existing hot-mix asphalt pavement.
 2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
 3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.4 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 - 2. Place hot-mix asphalt surface course in single lift.
 - 3. Spread mix at minimum temperature of 250 deg F.
 - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct lay down and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.10 WHEEL STOPS

- A. Install wheel stops in bed of adhesive as recommended by manufacturer.
- B. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
 - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 - 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- E. Replace and compact hot-mix asphalt where core tests were taken.

- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.
- G. Protection: Immediately after placement, protect pavement from mechanical injury for 2 days or until surface temperature is less than 140 degrees F.
- H. Special Testing: The contractor shall flood test the finished asphalt surface to identify potential areas for correction. The contractor shall notify the Project Manager and Landscape Architect for review of the flood testing. Areas that do not drain and pool water deeper than the depth of a nickel shall be identified and corrected as required.

3.12 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow milled materials to accumulate on-site.
 - 2. Remove excess base rock from edges of asphalt.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMAR

- A. Section Includes:
 - 1. Curbs and gutters.
 - 2. Walks.
 - 3. Mow strips.
- B. Related Sections:
 - 1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
- C. References:
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings.
 - 2. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
 - 3. ASTM A 615 - Specification for Deformed and Plain Billet-Steel for Concrete Reinforcement.
 - 4. ASTM C 33 - Specification for Concrete Aggregates.
 - 5. ASTM C 94 - Specification for Ready Mix Concrete.
 - 6. ASTM C 150 - Specification for Portland Cement
 - 7. ASTM C 260 - Specification for Air-Entraining Admixtures for Concrete.
 - 8. ASTM C 309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - 9. ASTM C 494 - Specification for Chemical Admixtures for Concrete.
 - 10. ASTM C 143 - Test Method for Slump of Portland Cement Concrete
 - 11. **2012** International Building Code.
 - 12. **ISPMC - Section 700 – Concrete. Idaho Standard Public Works Construction, current edition.**

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Product Data: Provide data on joint filler, admixtures and curing compounds.
- C. Submit shop drawings of reinforcing steel under provisions of Division 1.
- D. Indicate reinforcement sizes, spacing, locations and quantities of reinforcing steel, bending and cutting schedules, splicing, and supporting and spacing devices.
- E. Submit concrete slab control and expansion joint layout.
- F. Product Data: For each type of product indicated.
- G. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- H. Qualification Data: For qualified Installer of detectable warnings ready-mix concrete manufacturer and testing agency.
- I. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Fiber reinforcement.
 - 4. Admixtures.
 - 5. Curing compounds.
 - 6. Applied finish materials.
 - 7. Bonding agent or epoxy adhesive.
 - 8. Joint fillers.
- J. Material Test Reports: For Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- K. Field quality-control reports.
- L. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Perform work in accordance with ACI 301 requirements and State of Idaho Public Works Standards, Section 700.
- C. Obtain cementitious materials from same source throughout.

- D. Conform to **City of Boise and Ada County Highway District** supplemental specifications for paving work within right-of-way.
- E. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- F. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- G. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- H. ACI Publications: Comply with **ACI 301** unless otherwise indicated.
- I. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Quality control of concrete materials and concrete paving construction practices.
 - 2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Concrete paving subcontractor.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

- A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- C. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.
- D. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.
- E. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.
- F. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- G. Deformed-Steel Wire: ASTM A 496/A 496M.
- H. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- I. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.
- J. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- K. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- L. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

- M. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- N. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150, gray portland cement Type I. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class C.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: 1 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: Potable and complying with ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Axim Italcementi Group, Inc.; Caltexol CIMFILM.
 - b. BASF Construction Chemicals, LLC; Confilm.
 - c. ChemMasters; Spray-Film.
 - d. Conspec by Dayton Superior; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film (J-74).
 - f. Edoco by Dayton Superior; BurkeFilm.
 - g. Euclid Chemical Company (The), an RPM company; Eucobar.
 - h. Kaufman Products, Inc.; VaporAid.
 - i. Lambert Corporation; LAMBCO Skin.
 - j. L&M Construction Chemicals, Inc.; E-CON.
 - k. Meadows, W. R., Inc.; EVAPRE.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group; MONOFILM.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. SpecChem, LLC; Spec Film.
 - p. Symons by Dayton Superior; Finishing Aid.
 - q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
 - r. Unitex; PRO-FILM.
 - s. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anti-Hydro International, Inc.; A-H Curing Compound #2 DR WB.
 - b. ChemMasters; Safe-Cure Clear.
 - c. Conspec by Dayton Superior; DSSCC Clear Resin Cure.
 - d. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
 - e. Edoco by Dayton Superior; DSSCC Clear Resin Cure.
 - f. Euclid Chemical Company (The), an RPM company; Kurez W VOX.
 - g. Kaufman Products, Inc.; Thinfilm 420.
 - h. Lambert Corporation; AQUA KURE - CLEAR.
 - i. L&M Construction Chemicals, Inc.; L&M CURE R.
 - j. Meadows, W. R., Inc.; 1100-CLEAR SERIES.
 - k. Nox-Crete Products Group; Resin Cure E.
 - l. SpecChem, LLC; PaveCure Rez.
 - m. Symons by Dayton Superior; Resi-Chem Clear.
 - n. Tamms Industries, Inc., Euclid Chemical Company (The); TAMMSCURE WB 30C.
 - o. TK Products, Division of Sierra Corporation; TK-2519 WB.
 - p. Vexcon Chemicals Inc.; Certi-Vex Enviocure 100.

2.5 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
 - 1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.
 - 1. Products: Subject to compliance with requirements, provide the following provide one of the following:
 - a. ChemMasters; Exposee.
 - b. Conspec by Dayton Superior; Delay S.
 - c. Dayton Superior Corporation; Sure Etch (J-73).
 - d. Edoco by Dayton Superior; True Etch Surface Retarder.
 - e. Euclid Chemical Company (The), an RPM company; Surface Retarder Formula S.
 - f. Kaufman Products, Inc.; Expose.
 - g. Meadows, W. R., Inc.; TOP-STOP.
 - h. Metalcrete Industries; Surfard.
 - i. Nox-Crete Products Group; CRETE-NOX TA.
 - j. Scofield, L. M. Company; LITHOTEX Top Surface Retarder.
 - k. Sika Corporation, Inc.; Rugasol-S.
 - l. SpecChem, LLC; Spec Etch.
 - m. TK Products, Division of Sierra Corporation; TK-6000 Concrete Surface Retarder.
 - n. Unitex; TOP-ETCH Surface Retarder.
 - o. Vexcon Chemicals Inc.; Certi-Vex Envioset.

2.6 DETECTABLE WARNING MATERIALS

- A. Detectable Warning Products:
 - 1. Cast-in-Tact by Masco, or approved equal.

2.7 WHEEL STOPS

- A. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.

1. Dowels: Galvanized steel, 3/4 inch in diameter, 10-inch minimum length.

2.8 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
 2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
 1. Compressive Strength (28 Days): 4000 psi.
 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 3. Slump Limit: 4 inches, plus or minus 1 inch.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
 2. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 1. Use water-reducing and retarding admixture when approved by Architect and required by high temperatures, low humidity, or other adverse placement conditions.
- F. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals. as follows:
 1. Fly Ash or Pozzolan: 25 percent.
 2. Ground Granulated Blast-Furnace Slag: 50 percent.
 3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- G. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd..

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum **2-inch** overlap of adjacent mats.
- E. Install bar where indicated on plans and details.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 - 2. Provide tie bars at sides of paving strips where indicated.
 - 3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, building columns, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 40 feet unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 - 4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 5. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
 - a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 - a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
 - 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with **ACI 301** requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site.
- F. Do not add water to fresh concrete after testing.
- G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- H. Consolidate concrete according to **ACI 301** by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.
- I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
 - 1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.
- J. Screed paving surface with a straightedge and strike off.
- K. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- L. Curbs and Gutters: When automatic machine placement is used for curb placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.
- M. Slip-Form Paving: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce paving to required thickness, lines, grades, finish, and jointing as required for formed pavement.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
- N. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- O. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below **40 deg F**, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than **50 deg F** and not more than **80 deg F** at point of placement.
 2. Do not use frozen materials or materials containing ice or snow.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- P. Hot-Weather Placement: Comply with **ACI 301** and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below **90 deg F** at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface **1/16 to 1/8 inch** deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 DETECTABLE WARNINGS

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units as shown on plans.
1. Tolerance for Opening Size: Plus **1/4 inch**, no minus.

3.9 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.

- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching **0.2 lb/sq. ft. x h** before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing moisture-retaining-cover curing curing compound or a combination of these as follows:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with **12-inch** lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least **12 inches** and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: **1/4 inch**.
 - 2. Thickness: Plus **3/8 inch**, minus **1/4 inch**.
 - 3. Surface: Gap below **10-foot-** long, unlevelled straightedge not to exceed **1/2 inch**.
 - 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: **1/2 inch per 12 inches** of tie bar.
 - 5. Lateral Alignment and Spacing of Dowels: **1 inch**.
 - 6. Vertical Alignment of Dowels: **1/4 inch**.
 - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: **1/4 inch per 12 inches** of dowel.
 - 8. Joint Spacing: **3 inches**.
 - 9. Contraction Joint Depth: Plus **1/4 inch**, no minus.
 - 10. Joint Width: Plus **1/8 inch**, no minus.

3.11 WHEEL STOPS

- A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.

- B. Securely attach wheel stops to paving with not less than two galvanized-steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each 5000 sq. ft.] or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Remove and replace concrete paving where test results indicate that it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

3.13 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321400 - CONCRETE UNIT PAVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Concrete pavers set in aggregate setting bed.
- B. Related Sections include the following:
 - 1. Division 31 Section "Earthwork" for compacted subgrade and base course under unit pavers.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Concrete pavers.
- B. Samples for Verification: Full-size units of each type of unit paver indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
 - 1. Provide Product Samples.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article 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.

1.4 EXTRA MATERIALS

- A. Provide 20 of each paver.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: A company specializing in manufacturing products specified with not less than five years of documented experience.
- B. Installer Qualifications: An experienced installer who has completed unit paver installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
 - 1. Interlocking Concrete Pavement Institute (CIPI) certified contractor specializing in performing the work of this section with a minimum of three years of documented experience. All work shall be installed according to CIPI published guidelines.
- C. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

- D. Mockups: Before installing unit pavers, build mockups for each form and pattern of unit pavers required to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work, including same base construction, special features for expansion joints, and contiguous work as indicated:
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Obtain Architect's approval of mockups before starting unit paver installation.
 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 6. Demolish and remove mockups when directed.
 7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect unit pavers and aggregate during storage and construction against soiling or contamination from earth and other materials.
1. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.

1.7 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Concrete Pavers:
 - a. Basalite Concrete Products.

2.2 UNIT PAVERS

- A. Concrete Permeable Pavers: Solid, interlocking paving units, ASTM C 936, made from normal-weight aggregates in sizes and shapes indicated.
1. Compressive strength: 8000 psi average with minimum of 7200 psi.
 2. Thickness: 100mm.
 3. Style: 5.5"x 11" rectangle "Spec Pave 100" textured paver by Basalite Concrete Products, or approved equal.
 4. Color: Venice

2.3 AGGREGATE SETTING-BED MATERIALS

- A. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements of ASTM C 33 for fine aggregate.

2.4 ACCESSORIES

- A. Job-Built Concrete Edge Restraints: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 4000 psi (20 MPa).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Proof-roll prepared subgrade surface to check for unstable areas and areas requiring additional compaction. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive base for unit pavers.

3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible.
- B. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- C. Joint Pattern: Submit shop drawings.
- D. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.

3.4 AGGREGATE SETTING-BED PAVER APPLICATIONS

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 1557 laboratory density.
- B. Place aggregate base in thickness indicated. Compact by tamping with plate vibrator and screed to depth required to allow setting of pavers.
- C. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.
- D. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.
 - 1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

- E. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
 - 1. Before ending each day's work, fully compact installed concrete pavers to within 36 inches of the laying face. Cover open layers with nonstaining plastic sheets overlapped 48 inches on each side of the laying face to protect it from rain.
- F. Install ½" diameter steel dowels or rebar at lowest and highest course of pavers, 12" on center, to stabilize. Top of dowel/bar to be ½" below top of paver.
- G. Spread sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
- H. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- I. Apply commercial grade sealant per manufacturer's recommendations. Submit data sheet for review and approval prior to installation.

3.5 REPAIR AND PROTECTION

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units as intended. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Protection: Protect and maintain paver installation until accepted. Anticipate potential high water flows through paver installation prior to acceptance. Divert runoff and otherwise protect establishing turf from erosion and damage. Repair as required.

END OF SECTION 321400

SECTION 321713 - PARKING BUMPERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pre-cast concrete parking bumpers and anchorage.

1.2 REFERENCES

- A. ASTM C 150 - Specification for Portland Cement.
- B. ASTM A 615 - Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- C. ASTM C 33 - Specification Concrete Aggregates.

1.3 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Product Data: Provide unit configuration, dimensions.

1.4 QUALITY ASSURANCE - NOT USED.

1.5 DELIVERY, STORAGE AND HANDLING - NOT USED.

1.6 PROJECT/SITE CONDITIONS - NOT USED.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate work under provisions of Division 1
- B. Coordinate the work with pavement placement.

1.8 EXTENDED WARRANTY - NOT USED.

1.9 MAINTENANCE - NOT USED.

PART 2 - PRODUCTS

2.1 MANUFACTURERS - NOT USED.

2.2 MATERIALS

A. Concrete Bumpers

- 1. Cement: ASTM C 150, Portland Type II - Sulfate Resisting; gray color.
- 2. Concrete Materials: ASTM C 33; water and sand.
- 3. Reinforcing Steel: ASTM A 615, deformed steel bars; galvanized finish, strength and size commensurate with pre-cast unit design.
- 4. Concrete Mix: Minimum 2500 psi, 28 day strength, air entrained to 5 to 7 percent.

2.3 MANUFACTURED UNITS - NOT USED.

2.4 EQUIPMENT - NOT USED.

2.5 COMPONENTS - NOT USED.

2.6 ACCESSORIES

- A. Anchoring Dowels: Steel, galvanized finish; 3/4-inch diameter, 24-inch long, pointed tip.

2.7 MIXES - NOT USED.

2.8 FABRICATION

- A. Use rigid molds, constructed to maintain pre-cast units uniform in shape, size and finish. Maintain consistent quality during manufacture.
- B. Embed reinforcing steel, and drill or sleeve for two dowels.
- C. Cure units to develop concrete quality, and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
- D. Configuration
 - 1. Nominal Size: 5 inches high, 9 inches wide, 6 feet long.
 - 2. Profile: Manufacturer's standard.

2.9 SOURCE QUALITY CONTROL - NOT USED.

PART 3 - EXECUTION

3.1 EXAMINATION - NOT USED.

3.2 PREPARATION - NOT USED.

3.3 ERECTION

- A. Install units without damage to shape or finish. Replace or repair damaged units.
- B. Install units in alignment with adjacent work.
- C. Fasten units in place with 2 dowels per unit bumper.

3.4 FIELD QUALITY CONTROL - NOT USED.

3.5 ADJUSTING - NOT USED.

3.6 CLEANING - NOT USED.

3.7 DEMONSTRATION - NOT USED.

3.8 PROTECTION - NOT USED.

3.9 SCHEDULES

- A. Parking Area: Where shown on drawings. Grey cement, smooth surface finish, dowelled.

END OF SECTION 321713

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fence framework, fabric, and accessories.
- B. Excavation for post bases; concrete foundation for posts.
- C. Manual gates and related hardware.
- D. Temporary Construction Fencing.

1.2 RELATED SECTIONS

- A. Section 033000 - Cast-In-Place Concrete: Concrete anchorage for posts.

1.3 REFERENCES

- A. ASTM A 116 - Standard Specification for Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric; 1995.
- B. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2000.
- C. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2000.
- D. ASTM A 392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 1996.
- E. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2000.
- F. ASTM F 567 - Standard Practice for Installation of Chain-Link Fence; 2000.
- G. ASTM 900 – Standards Specifications for Industrial and Commercial Swing Gates.
- H. ASTM F 969-96 – Standard Practice for Construction of Chain-link Tennis Court Fencing.
- I. ASTM F 1043 – Standard Specifications for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
- J. ASTM F 1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 1997.
- K. CLFMI CLF 2445 - Product Manual; Chain Link Fence Manufacturers Institute; 1997.

1.4 SUBMITTALS

- A. See Section 013300 – Project Management and Coordination for submittal procedures.
- B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. Contractor shall submit post footing recommendation for structural review and approval prior to installation.
- D. Manufacturer's Installation Instructions: Indicate installation requirements and recommended methods.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Chain Link Fences and Gates:
 - 1. Allied Tube and Conduit Corporation.
 - 2. American Fence Corporation.
 - 3. Anchor Fence, Inc.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.2 MATERIALS

- A. Posts, Rails, and Frames: ASTM F 1083 Schedule 40 or SS40 hot-dipped galvanized steel pipe, welded construction, minimum yield strength of 25 ksi.
- B. Wire Fabric – Perimeter Fence: 2-inch mesh, 9 gauge, ASTM A 392 vinyl coating (steel chain-link fabric) and powder coating (fence posts), knuckled selvages at top and tension wire bottom of fabric. Color per Architect.
- C. Wire Fabric-Tennis Courts: 1.75 inch mesh, 11 gauge, ASTM A 392 zinc coated steel chain-link fabric with 1.2 oz. per square foot, knuckled selvages at top and bottom of fabric.
- D. Concrete: Type specified in Section 033000.

2.3 COMPONENTS

- A. Line Posts: 1.9 inch diameter for up to 5' high, max. spacing 10' o.c.
- B. Line Posts: 2.38 inch diameter for over 5' high, max. spacing 10' o.c.

- C. Corner and Terminal Posts: 2.38 inch for up to 5'.
- D. Corner and Terminal Posts: 2.875 inch for over 5'.
- E. Gate Posts: 2.875 inch diameter for gate leaf 6' and under.
- F. Gate Posts: 4 inch diameter for gate leaf 6' to 10'.
- G. Gate Posts: 6.625 inch diameter for gate leaf 10' to 20'.
- H. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.
- I. Gate Frame: 1.90 inch diameter for welded fabrication.
- J. Fabric: Diamond mesh interwoven wire, top selvage knuckle end closed, bottom selvage knuckle end closed.
- K. Tension Wire: 7 gage thick steel, single strand, finish to match fabric.
- L. Tension Bar: 3/16 x 3/4 inch thick steel.
- M. Tie Wire: 9-gauge Aluminum alloy or 11 gauge galvanized steel wire.
- N. Post Brace Assembly: Install per manufacturer's recommendations
 - 1. Horizontal Brace: 1.66 inch diameter, length and fittings as required.
 - 2. Truss Rod: 0.375 inch diameter steel rod, length adjusted as required.

2.4 ACCESSORIES

- A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.
- C. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.

2.5 FINISHES – PERIMETER FENCING

- A. Components (Other than Fabric): Galvanized in accordance with ASTM A 123/A 123M, at 2.0 oz/sq ft.
- B. Hardware: Vinyl coating (fabric), color per Architect.
- C. Accessories: Powder coating (fence posts), color per Architect.

2.6 FINISHES – TENNIS COURT FENCING

- A. Components (Other than Fabric): Galvanized in accordance with ASTM A 123/A 123M, at 2.0

oz/sq ft.

- B. Hardware: Hot-dip galvanized to weight required by ASTM A 153/A 153M.
- C. Accessories: Same finish as framing.

2.7 CONSTRUCTION FENCING

- A. Components
 - 1. 10 - 20 foot long chain link panels, including frame and fabric, which have posts set on frame legs for surface installation. The panels shall be portable, 6 feet high and provide means for panel to panel connection. Continuous chain link fabric install with "T" posts is option and must be approved by the Architect and Owner.
 - 2. Locate as required in quantities sufficient to control access to construction site activities.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify finished grades are complete prior to installation.
- B. Install framework, fabric, accessories and gates in accordance with ASTM F 567.
- C. Place fabric on inside of posts and rails.
- D. Set intermediate posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.
- E. Line Post Footing Depth Below Finish Grade: ASTM F 567.
- F. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F 567.
- G. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gateposts.
- H. Provide top rail through line post tops and splice with 6 inch long rail sleeves.
- I. Install center brace rail on corner gate leaves.
- J. Do not stretch fabric until concrete foundation has cured 28 days.
- K. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
- L. Position bottom of fabric 2 inches above finished grade.
- M. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers. Bend ends of wire to minimize hazard to persons or clothing.
- N. Attach fabric to end, corner, and gateposts with tension bars and tension bar clips.

- O. Install bottom tension wire stretched taut between terminal posts. Attach to fabric with hog rings.
- P. Do not attach the hinged side of gate to building wall; provide gateposts.
- Q. Install gate with fabric to match fence. Install hardware.
- R. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.
- S. Adjust gate to operate smoothly, easily, and quietly, free from binding, wrap, excessive deflection, distortion, non-alignment, or malfunction throughout the entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding. Lubricate hardware and other moving parts.

3.2 ERECTION TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.
- C. Components shall not infringe adjacent property lines.

END OF SECTION 323113

SECTION 323150 - SITE SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Traffic control signage. Signs shall be constructed of aluminum sheeting and shall be reflectorized.
 - 2. Signage furnished and installed per drawings and in accordance with the current edition of the Manual for Uniform Traffic Control Design (MUTCD).

1.3 SUBMITTALS

- A. See Section 013300 – Project Management and Coordination for submittal procedures.
- B. Product Data: Provide Manufacturer's (catalog) product information.
- C. Shop drawings: Indicate graphic features of signage and location where signage is to be installed.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years experience.

1.5 PROJECT CONDITIONS

- A. Coordinate sign installation with size, location and installation of service utilities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Best Sign Systems

- B. ASI Sign Systems Inc.
- C. Charleston Industries, Inc.
- D. Substitutions under provisions of Section 016000.

2.2 MATERIALS

- A. Sheet aluminum shall be 6060-T6 Alloy, .080" thick.
- B. Reflective sign facing shall consist of spherical lens elements either embedded within a transparent plastic or adhered to a synthetic resin and encapsulated by a transparent plastic.
- C. Post shall be perforated 2" x 2" galvanized steel post, square section. Provide caps where detailed.
- D. Signs and posts shall be assembled with 5/16" x 3-1/4" galvanized machine screws and 1" O.D. nylon washers, locknuts with nylon inserts, two screws per sign.
- E. Galvanized steel sign post sockets shall be provided which fit the sign post profile and permit replacement of damaged sign posts.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that the finish grade level has been determined for signage location prior to installation.

3.2 INSTALLATION

- A. Traffic sign post sockets shall have 3'-0" embedded below the finish site grade.
 - 1. Sign post sockets shall be cast into Portland cement concrete, the surface finished to form a 12" diameter cap that directs water away from the post, post sockets installed in Portland cement concrete paving areas shall be installed with similar detail created during concrete placement and finishing.
- B. Install sign posts plumb, signs level. Make corrections if required at direction of Landscape Architect.

3.3 ERECTION TOLERANCES

- A. Maximum Variation from Plumb: 1/4".

END OF SECTION 323150

SECTION 323180 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Trash Receptacles.
- B. Anti-skateboard devices.

1.2 REFERENCES

- A. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2000.
- B. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2000.
- C. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2000.
- D. ASTM A 325M - Standard Specification for High-Strength Bolts for Structural Steel Joints (Metric); 2000.
- E. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 2000.

1.3 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Product Data: Manufacturer's data sheets on each product specified, including detailed installation diagrams and recommended installation methods.
- C. Selection Samples: For each product specified, two complete sets of chips representing manufacturer's full range of colors and finishes.

1.4 QUALITY ASSURANCE

- A. Furnish paint for touch-up as required
- B. Install pre-manufactured items, poured-in-place or pre-cast items, and all related materials required to complete the work indicated on the drawings and/or specified.
- C. Substitutions: The intent of these specifications is to describe pre-manufactured items of minimum acceptability with regard to materials, construction, size, configuration, and finish. Substitutions will be accepted under provisions and shall be compatible with overall design theme.
- D. Materials Inspection: The Contractor shall inspect all items upon delivery to ensure no damage to material or finish. Minor repairs and/or touch up shall be accepted only upon prior authorization from the Architect and shall conform, at minimum, to manufacturer's standard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS- NOT USED

2.2 MATERIALS

- A. Steel Structural Supports:
 - 1. Steel Plate: ASTM A 283/A 283M.

2. Steel Pipe: ASTM A 53, Grade B Schedule 40, hot-dip galvanized finish.
3. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M).
- B. Welding Materials: AWS D1.1; type required for materials being welded.

2.3 SITE FURNISHINGS

- A. Trash Receptacles:
Victor Stanley SteelSite Series, 36 gallon Gray round receptacle with tapered formed lid and interior liner, model no. RB-36. www.victorstanley.com, 1-800-368-2573 Quantity: one
- B. Anti-skateboard device:
Skatestoppers D135-8 for chamfer Skate Deterrent, as manufactured by intelliccept, or approved equal. Cast into concrete wall installation and spacing per manufacturer's recommendations. www.skatestoppers.com, 619-447-6374.

2.4 FABRICATION

- A. Shop assemble site furnishings for delivery to site in units easily handled and to permit shipment without disassembly.

2.5 ACCESSORIES

- A. Provide all anchorage devices and materials required for a complete installation.

PART 3 -EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 ADJUSTING

- A. Upon completion of the installation of site furnishings, check each items and verify that all equipment is properly installed; verify that all trim is in place; adjust all components as necessary to ensure proper operation; remove all labels from equipment.
- B. Make necessary adjustments for safe, efficient and smooth operation.

3.4 CLEANING

- A. Remove all packing materials from job site.
- B. Clean or restore marred surfaces.

3.5 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products after Substantial Completion.

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END OF SECTION 323180

SECTION 323190 - FLAGPOLE

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Tapered Aluminum flagpole, ground mounted.
 - 2. 5'x 8' United States of America Flag.

1.2 RELATED SECTIONS

- A. Concrete base and foundation construction.

1.3 REFERENCES

- A. AASHTO M-36 - Corrugated Metal Culvert Pipe.
- B. ASTM A53 - Pipe, steel, black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- C. ASTM A123 - Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products.

1.4 PERFORMANCE REQUIREMENTS

- A. Flagpole With United States of America Flag: Resistant without permanent deformation to 90 miles/hr; non-resonant, safety design factor of 2.5.

1.5 SUBMITTALS

- A. Product Data: Provide data on pole, accessories and configurations.
- B. Samples: Submit two samples 4 x 4 inch in size illustrating pole material, color and finish.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Spiral wrap flagpole with protective covering and pack in protective shipping tubes or containers.
- B. Protect flagpole and accessories from damage or moisture.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Flagpole shall be Model# ALWIN3056 with lock box from the American Flag Store, <http://www.americanflagstore.com/alflagpoles/30ftintwinchaluminum.htm> ; (888) 317-4594, or approved equal prior to bidding.

2.2 POLE MATERIALS

- A. One piece cone tapered seamless aluminum shaft, 6063-T6 alloy.

2.3 POLE CONFIGURATION

- A. Outside Butt Diameter: 6 inches.
- B. Outside Top Diameter: 3.5 inches.
- C. Nominal Wall Thickness: .156 inch.
- D. Nominal Height: 30 feet, measured from nominal ground elevation.

- E. Flagpole: Ground-mounted type.
- F. Flagpole Design: Cone tapered.
- G. Halyard: Internal Halyard with internal winch assembly.

2.4 COMPONENTS AND ACCESSORIES

- A. Finial: 5 inch gold anodized spun aluminum ball with flush seam.
- B. Truck Assembly: Cast aluminum, revolving, stainless steel ball bearings, non-fouling.
- C. Internal Concealed Cam-Action Cleat: With lockable access door.
- D. Halyard: stainless steel aircraft cable; two chrome-plate swivel snaphooks with vinyl covers; neoprene covered counterweight, beaded retainer ring.
- E. 5'x 8' United States of America Flag.

2.5 OPERATOR

- A. Hand Crank

2.6 MOUNTING COMPONENTS

- A. Foundation Tube Sleeve: AASHTO M-36, corrugated (16) gage steel, galvanized, 3'-6" depth
- B. Pole Base Attachment: Flush aluminum base with base cover.

2.7 FINISHES

- A. Metal Surfaces in Contact with Concrete: Asphaltic paint.
- B. Concealed Steel Surfaces: Prime painted.
- C. Exposed to View Steel Surfaces: Field painted, color as selected (Natural Anodized).
- D. Finial: Gold anodized finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify site conditions under provisions of Division 1.
- B. Verify that concrete foundation is ready to receive work and dimensions are as instructed by the manufacturer..

3.2 PREPARATION

- A. Coat metal sleeve surfaces below grade and surfaces in contact with dissimilar materials with asphaltic paint.

3.3 INSTALLATION

- A. Install flagpole, base assembly and fittings in accordance with manufacturer's instructions.
- B. Fill foundation tube sleeve with sand specified and compact.
- C. Install foundation plate and centering wedges for flagpoles base set in concrete base and fasten.

3.4 ERECTION TOLERANCES

- A. Maximum variation from Plumb: 1 inch (25mm).

3.5 ADJUSTING

- A. Adjust operating devices so that halyard and flag function smoothly.

END OF SECTION 323190

SECTION 328400 - LANDSCAPE IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Pipe and fittings, valves, sprinkler heads, accessories, and connections to water source.
 - 2. Control system.
- B. System Description
 - 1. Electric solenoid controlled automatic underground irrigation system.
- C. Related Sections
 - 1. Division 16 Sections for electrical power materials and installations.

1.2 DEFINITIONS

- A. Pipe sizes used in this Section are nominal pipe size (NPS) in inches. Tube sizes are Standard size in inches.
- B. Pressure Piping Main Line: Piping downstream from supply piping to and including control valves. Piping is under irrigation system pressure. Piping in this category includes backflow preventers.
- C. Circuit Piping Lateral Lines: Piping downstream from control valves to irrigation system sprinklers. Piping is under pressure (less than pressure piping) during flow.
- D. Control Valve: Automatic (electrically operated) valve for control water flow to irrigation system zone.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Location of Sprinklers and Devices: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards.
- B. Minimum Water Coverage: Not less than:
 - 1. Turf Areas: 100 percent.
 - 2. Other Planting Areas: 100 percent.
- C. All flow velocities, within the entire irrigation system, shall not exceed 5 feet per second.

1.4 SUBMITTALS

- A. Product data including pressure rating, rated capacity, settings, and electrical data of selected models for the following:
 - 1. Backflow preventers, including test equipment.
 - 2. Valves, including general-duty, underground, automatic control, and quick-coupler types, isolation and valve boxes.
 - 3. Sprinklers.
 - 4. Irrigation Controller, including controller wiring diagrams.
 - 5. Wiring.
 - 6. Irrigation system record drawings.
 - 7. Pipe fittings.
- B. Wiring diagrams for electrical controllers, valves, and devices. Valve numbers shall reflect station numbers within the controller and shall be noted on the as-builts.

- C. Maintenance data for inclusion in "Operating and Maintenance Manual" specified in Division 1 Section "Contract Closeout" for the following:
 - 1. Seasonal activities of start-up, shut-down and winterization, including blow-out operation of sprinkler system with compressed air.
 - 2. Backflow preventers, including instructions for testing.
 - 3. Automatic control valves.
 - 4. Sprinklers.
 - 5. Controllers.
 - 6. Irrigation system record drawings.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of utility supplying water for prevention of backflow and backsiphonage. Comply with appropriated water rights.
- B. Installer Qualifications: Engage an experienced Installer with a minimum of five years experience and who has completed irrigation systems similar in material, design, and extent to that indicated for Projects that have resulted in construction with a record of successful in-service performance.
- C. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.
- D. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in "National Electrical Code," Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- E. Product Options: Irrigation system piping, specialties, and accessories are based on specific types, manufacturers, and models indicated. Components with equal performance characteristics produced by other manufacturers may be considered, provided deviations in dimensions, operation, and other characteristics do not change design concept or intended performance as judged by the Landscape Architect. The burden of proof of product equality is on the Contractor. Any substitutions must be approved by the Architect in writing prior to installation per section 1.10.

1.6 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Verify that irrigation system piping may be installed in compliance with original design and referenced standards. Verify that pump and domestic supply perform as specified.

1.7 SEQUENCING AND SCHEDULING

- A. Maintain uninterrupted water service to building during normal working hours. Arrange for temporary water shutoff with Owner.
- B. Maintain Uninterrupted existing irrigation system during construction. Arrange for temporary water shutoff with owner. Provide alternate water source for irrigation if water is to be shut off for more than three (3) days.
- C. Coordinate irrigation systems work with landscape work specified in "Plants" Section ".

1.8 EXTRA MATERIALS

- A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below. Package them with protective covering for storage and label clearly describing contents.

1. Quick Couplers: Furnish quantity of units equal to 2 percent of amount of each size installed.
2. Sprinklers: Furnish quantity of units equal to 5 percent of amount of each type installed.
3. Valve Keys: Furnish quantity of tee-handle units equal to 2 percent of amount of each type key-operated, control valve installed.
4. Quick-Coupler Hose Swivels: Furnish one for each quick coupler installed.
5. Quick-Coupler Operating Keys: Furnish one for each quick coupler installed.

1.9 IRRIGATION RECORD DRAWINGS

- A. Record accurately, on one set of black and white prints of the site plan **(to be on site at all times during installation)**, all installed work including both pressure and non-pressure lines and pipe sizes.
- B. Upon completion of each increment of work, transfer all such information and dimensions to the print. The dimensions shall be recorded in a legible and workmanlike manner. Maintain as-built drawings on site at all times. Make all notes on drawing in pencil (no ball point pen). When the work has been completed, transfer all information from the field record print to a set of reproducible drawings.
- C. Dimension from two permanent points of reference (buildings, monuments, sidewalks, curbs, pavements, etc.). Locations shown on as-built drawings shall be kept day to day as the project is being installed. All dimension text noted on drawings shall be 1/8 inch in size (minimum).
- D. Show locations and depths of the following items:
 1. Point of connection, including Flow Sensor Assembly
 2. Routing of sprinkler pressure lines
 3. Gate valves
 4. Sprinkler control valves
 5. Quick coupling valves
 6. Routing of control wires, including Flow Sensor Assembly wires
 7. Sprinkler heads
 8. Other related equipment

1.10 SUBSTITUTIONS

- A. Coordinate substitutions per Division One.
- B. Substitutions to the specified equipment will be permitted with the express written approval of the Landscape Architect. Substitutions will be approved only when the substituted item is equivalent or better in quality and performance than the item originally specified. The final determination for "equivalents" rests with the Landscape Architect. Their decision shall be final and binding.

1.11 WARRANTY

- A. Warranty system against defects of installation and material for a period of 1 year after final completion of the irrigation system. Guarantee shall also cover repair or damage to any part of the premises resulting from leaks or other defects in material, equipment and workmanship to the satisfaction of the Architect. Repairs, if required, shall be done promptly upon notification by the Owner, and, at no cost to the Owner.
- B. As part of the warranty, the Contractor shall be responsible for deactivating and winterizing the system prior to the onset of the freezing season and for reactivating the system at the onset of the spring growing season; each event must be accomplished once during the warranty period. In the event the system is completed in a season when it will not be in use,

the Contractor shall winterize the system upon completion of testing (and approval by the Landscape Architect) and reactivate the system in the spring. The Contractor shall SUBMIT a letter to the Landscape Architect certifying that the system was winterized and drained and indicate the date such action was accomplished. The Contractor shall be responsible for any damage resulting from failure to comply. Contractor shall instruct and demonstrate winterization and startup techniques for Owner.

PART 2 - PRODUCTS

2.1 SUMMARY

- A. All materials used throughout the system shall be new, unused, and in perfect condition. Refer to the irrigation materials legend, notes, detail drawings and these specifications for specific equipment to be used. Equipment or materials installed or furnished without prior approval of the Architect may be rejected and the Contractor required to remove such materials from the site at his own expense.
- B. Substitutions: Under provisions of Division 1 and 328400, paragraph 1.10.

2.2 BRASS PIPE AND ACCESSORIES

- A. Pipe: ASTM B43, Schedule 40; domestic manufacture
- B. Fittings: Medium brass, screwed, 125-pound class.

2.3 PLASTIC PIPE AND ACCESSORIES

- A. Pipe
 - 1. Pipe walls shall be uniform, smooth, glossy, and free of interior or exterior extrusion marks; pre-belled or straight to receive solvent-weld couplings; 20 foot standard lengths.
 - 2. Pipe shall be marked with manufacturer's name, class of pipe, NSF seal, and date/shift of manufacturing run.
 - 3. PVC Pipe: ASTM D1785, D2241
- B. Fittings: PVC - ASTM D2464, D2466.
- C. Irrigation System Plastic Pipe
 - 1. Mainline: 3 inch pipe and larger: PVC schedule 40 with SDR21 rubber gasket fittings. 2 ½ inch pipe and smaller: PVC schedule 40 pipe with SDR21 solvent weld fittings.
 - 2. Laterals: 3 inch pipe and larger: PVC schedule 40 with SDR21 rubber gasket fittings. 2 ½ inch pipe and smaller: PVC schedule 40 pipe with SDR21 solvent weld fittings.
 - 3. Sleeving: ASTM D 1785, schedule 40, polyvinyl chloride (PVC) plastic pipe; ASTM D 2466, Schedule 40, PVC plastic, socket-type fittings; and solvent-cemented joints.
 - 4. Refer to Part 3 Article "Piping Applications" for identification of systems where pipe and tube materials specified below are used.
 - 5. Polyvinyl Chloride (PVC) Plastic Pipe: ASTM D 1785; PVC 1120, SDR 21, 200 psig (1380 kPa) minimum pressure rating, with plain ends. Schedule 40 upstream from controls, as noted on the drawings; schedule 40 downstream.
- D. Pipe and Tube Fittings
 - 1. Refer to Part 3 Article "Piping Applications" for identification of systems where pipe and tube fitting materials specified below are used.
 - 2. Polyvinyl Chloride (PVC) Plastic Pipe Fittings: ASTM D 2464, Schedule 80,

- threaded.
- 3. Polyvinyl Chloride (PVC) Plastic Pipe Fittings: ASTM D 2467, Schedule 40, socket-type.
- 4. "Leemco" Push-on joint Ductile Fittings or approved equal: for all pipes 2 1/2" and larger.
- 5. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion. These devices are a combination of copper alloy and ferrous metal; threaded- and solder-end types, matching piping system materials.
 - a. Dielectric Unions: Factory-fabricated, union assembly, designed for 250 psig (1725 kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material isolating dissimilar metals and ends with inside threads according to ASME B1.20.1.
 - b. Transition Fittings: Manufactured assembly or fitting, with pressure rating at least equal to that of system and with ends.

2.4 JOINING MATERIALS

- A. Solvent Cement: ASTM F 656 primer and ASTM D 2564 solvent cement in color other than orange.

2.5 VALVES

- A. General: Valves are for general-duty and underground applications. Refer to "Valve Applications" Article for locations of various valve types specified in this Article. Refer to "Control Valves" Article for control valves and accessories.

2.6 CONTROL VALVES

- A. Description: Manufacturer's standard control valves for circuits, of type and size indicated on Drawing, and as follows:
 - 1. Angle Valves: Bronze construction, non-rising stem, inside screw threaded ends and as noted on the Drawings.
 - 2. Automatic Control Valves: Diaphragm-type, normally closed, with manual flow adjustment, and operated by 24-volt-a.c. solenoid.
 - 3. Quick-Couplers: Factory-fabricated, 2-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.
 - a. Locking Top : Include vandal-resistant, locking feature with 2 matching keys.
 - 4. Drain Valve: As noted on the Drawings.
 - 5. Isolation Gate Valves: 150# gate valve, epoxy-coated, ductile iron, resilient wedge valve with non-rising stem and inside screw with threaded ends. Mechanical joint or push-on. "Waterous", "American Flow Control" or "Nibco" gate valves or approved equal prior to bidding. Size to match line size. Install in valve box, size adequate for maintenance access. Minimum 15" x 21".
 - 6. Air release valve: 2" air release valve from "Crispin", install in valve box.
 - 7. Master Valve/ Flow Sensor Assembly: Netafim Hydrometer, size to match main line, or approved equal.
 - 8. "Leemco" Ductile Iron Lateral Connection System or approved equal.

- B. Control Valve Boxes and Cover: Thermo-plastic valve boxes with lockable, snap-top lids. Size as required for application or as noted on drawings, maximum one (1) valve per box. All boxes shall have purple lids labeled "DO NOT DRINK".
 - 1. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3 inches (75 mm) maximum to 3/4 inch (19 mm) minimum. Cover gravel with layer of filter fabric.
- C. Service Boxes for Key-Operated Control Valves: Size and type as shown on Drawings.
 - 1. Include valve key, 48 inches (915 mm) long with tee handle and key end to fit valve.
- D. Irrigation System Controls
 - 1. Controller: As noted on the Drawings. All control wiring that is above ground shall be installed in conduit. Electrical wiring shall be installed according to local code. Provide surge protectors install controllers.
 - 2. Controller Housing: Weatherproof, watertight, with lockable access door.
 - 3. Valves: Electric Solenoid type and size of control valves as noted on the Drawings, including required fittings and accessories.
 - 4. Wire: Color coded, copper conductor direct burial, UF-UL listed as noted on the drawings.

2.7 SPRINKLERS

- A. Description: Manufacturer's standard sprinklers designed to provide uniform coverage over entire area of spray shown on Drawings at available water pressure, as follows:
 - 1. Housings: Plastic, except where material is specified.
 - 2. Pop-Up, Spray: Fixed pattern, with screw-type flow adjustment and stainless-steel retraction spring.
 - 3. Pop-Up, Rotary Spray: Gear drive, full-circle and adjustable part-circle type.
 - 4. All sprinkler heads shall have purple non-potable water caps.

2.8 AUTOMATIC CONTROL SYSTEM

- A. Description: Low-voltage controller system, made for control of irrigation system automatic control valves. Controller operates on 120 volts a.c. building power system, provides 24 volts a.c. power to control valves, and includes stations for at least the number of control valves indicated. Size and type as shown on Drawing.
- B. Control Enclosures: Weatherproof enclosure with locking cover and 2 matching keys. Enclosure construction complies with NFPA 70 and NEMA 250, Type 4, and includes provision for grounding. All control wiring that is above ground shall be installed in conduit. Electrical wiring shall be installed according to local code. Provide surge protectors in all controllers.
 - 1. AG 240 V Surge Arrester: As noted on the drawing. Install in approved J-box next to controller. Install per manufacturer recommendations.
 - 2. Stainless Steel Wall Mounted Enclosure by Strong Box Item #B-16SSW or approved equal.
- C. Transformer: Internal-type, and suitable for converting 120 volts a.c. building power to 24 volts a.c. power.
- D. Controller Stations for Automatic Control Valves: Each station is variable from approximately 1 to 60 minutes. Include switch for manual or automatic operation of each station.
- E. Timing Device: Adjustable, 24-hour, 14-day clock to operate any time of day. Include provision for the following settings:
 - 1. Setting to skip operation any day in timer period.
 - 2. Setting for operation every other day.
 - 3. Settings for operation 2 or more times daily.

4. Include manual or semi-automatic operation without disturbing preset automatic operation.
5. Provide NI-CAD battery and trickle charger to automatically power the timing device during power outages.
- F. Wiring: UL 493, solid copper conductor, insulated cable, suitable for direct burial.
 1. Splicing Materials: Pressure-sensitive, waterproof, thermoplastic wire connectors and other materials required to make specified connections. Locate all splice within valve boxes.
 2. Decoder Wire to be size # 14 not to exceed 10,000 Linear feet before sizing up to #12 wire.
- G. Communication Cable.
 1. All cable required for the 2-wire paths and from Controller to flow sensor shall be REA Pe-39, 19 gauge, conductor-solid annealed uncoated copper conforming to ASTM-B3; insulated with expanded polyolefin surrounded by solid polymer to ensure low loss long transmission capability. Communication cable shall be of a type and size manufactured for use with Baseline hardware and approved by Baseline for installation of this type.
 2. Cable for the 2-wire paths shall be installed with no underground splices. All cable shall be laid in trenches ("pulling-in" of cable for installation without trenching will not be allowed unless pre-approved by the Landscape Architect) and shall be carefully back-filled to avoid any damages to the cable insulation or cable conductors themselves. In rocky areas, the trench shall have a 6" layer of clean sand on the bottom before the cable is laid into the trench and back-filled. If rocky back-fill is being used, the cable shall have an additional 6" layer of sand on top of it before back-filling is started. The cable shall have a minimum of 18" of cover.
 3. All 2-wire shall be installed in a PVC schedule 40 conduit and a sleeve (where passed under paving, walls or any other paved areas) of proper size required for the number of cables to be placed in it. The 2-wire path is permitted to be laid in the same trench with the 117 VAC cable as much as possible by laying each in opposite sides of the trench.

2.9 VALVE BOXES

- A. Carson Industries or approved equal green body with locking lid. Standard rectangular box, model L series 1220-12 with T-cover, for all electrical control valves, 1419-12B. 10" round box for all mainline ball valves, gate valves, and hose bibs. All boxes shall have purple lids labeled "Do not Drink".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Investigate and determine available water supply water pressure and flow characteristics.
- B. Insure that new pump station is providing necessary performance. Notify Landscape Architect of any deviations from design performance.

3.2 PREPARATION

- A. Set stakes to identify proposed sprinkler locations. Obtain Irrigation Designer's approval before excavation.

3.3 PAVING WORK

- A. Install piping in sleeves where crossing sidewalks, roadways, parking lots, playgrounds and railroads.
 - 1. Install piping sleeves by boring or jacking under existing paving, where possible.
 - 2. If it is necessary to cut pavement sections, pavement shall be replaced in cut areas per ISPWC standards and requirements.

3.4 PIPING APPLICATIONS

- A. Refer to Part 2 of this Section for detailed specifications for pipe and fittings products listed below. Use pipe, tube, fittings, and joining methods according to the following applications. Piping in pits and aboveground may be joined with flanges instead of joints indicated.
- B. Use pipe, tube, fittings, and joining methods according to the following applications.
- C. Pressure Piping Underground: Use the following:
 - 1. 2 ½ Inches (DN 80) and Smaller: ASTM D 2467, Schedule 40, PVC plastic, socket-type pipe fittings; and solvent-cemented joints.
 - 2. 3 -Inches (DN 100) and Larger: ASTM D 2241, rubber gasketed Schedule 40, polyvinyl chloride (PVC) plastic pipe; ASTM A 536 push on ductile iron fittings.
- D. Circuit Piping: Use the following:
 - 1. All Sizes: ASTM D 2241, ASTM D 2466, Schedule 40, polyvinyl chloride (PVC) plastic, socket-type fittings; and solvent-cemented joints.
- E. Sleeves: ASTM D 2466, Schedule 40, polyvinyl chloride (PVC) PVC plastic, socket-type fittings; and solvent-cemented joints. Sleeve diameter shall be two sizes larger than pipe installed in sleeve with minimum sleeve size being 4". Extend sleeves 12" minimum beyond walk or pavement edge.

3.5 JOINT CONSTRUCTION

- A. Threaded Joints: Thread pipes with tapered pipe threads according to ASME B1.20.1, apply tape or joint compound, and apply wrench to valve ends into which pipes are being threaded.
- B. Polyvinyl Chloride (PVC) Piping Solvent-Cemented Joints: Construct joints according to ASTM D 2672 and ASTM D 2855.
 - 1. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F 402 for safe handling when joining plastic pipe and fittings with solvent cements.
- C. Dissimilar Materials Piping Joints: Construct joints using adapters that are compatible with both piping materials, outside diameters, and system working pressure. Refer to "Piping Systems - Common Requirements" Article for joining dissimilar metal piping.
- D. Provide "Leemco" joint restraints at all gasket fittings where a change of direction occurs. Install all joint restraints per manufacturer's recommendations.

3.6 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, and in other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.
- B. Install components having pressure rating equal to or greater than system operating pressure.
- C. Install piping free of sags and bends. Deflections angles shall not exceed manufacturer's recommendations.
- D. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

- E. Install fittings for changes in direction and branch connections.
- F. Piping Connections: Except as otherwise indicated make piping connections as specified below.
 - 1. Install unions, in piping 2 inches (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment having 2-inch (DN 50) or smaller threaded pipe connection.
 - 2. Install flanges, in piping 2-1/2 inches (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
 - 3. Install dielectric fittings to connect piping of dissimilar metals.

3.7 PIPING INSTALLATION

- A. Install underground polyvinyl chloride (PVC) plastic pipe according to ASTM D 2774.
- B. Lay piping on solid subbase, uniformly sloped without humps or depressions.
 - 1. Install polyvinyl chloride (PVC) plastic pipe in dry weather when temperature is above 40 deg F (4 deg C). Allow joints to cure at least 24 hours at temperature above 40 deg F (4 deg C) before testing, unless otherwise recommended by manufacturer.
- C. Minimum Cover: Provide following minimum cover over top of buried piping:
 - 1. Pressure Piping: 18 inches.
 - 2. Circuit Piping: 12 inches.
 - 3. Sleeves: 24 inches.
- D. Boring
 - 1. Locations: Boring shall be used to route pipe, wiring or both under concrete structures such as walks or curbs where trenching is impractical. Sleeves shall be installed in all bored holes.
 - 2. Method: Boring shall be accomplished with a drill, auger, water jet, or any other instrument approved by the Owner's Representative capable of producing a precise hole. Boring shall not disturb overlaying structures or cause settlement and damage to those structures. Repair or replace any pavement damaged during boring procedures.
- E. Install piping under sidewalks and paving in sleeves.
- F. Back-filling
 - 1. Inspection: The trenching shall not be backfilled until inspection and pressure testing has been completed and the pipe installation, including the grade, alignment and jointing has been found to be in compliance with the requirements of the plans and specifications.
 - 2. Around and Over Pipe:
 - a. Select backfill material consisting of sand, fine gravel or select earth, free of large lumps or rocks larger than 1/2 inch shall be used in backfilling around and over the installed pipe.
 - b. The select material shall be obtained from the excavation material removed from the trench and shall be processed by screening, sifting, or selective sorting, so as to produce the type of backfill herein specified. The Contractor may at his option and own expense provide an acceptable imported material.
 - c. Backfill material shall be carefully deposited around and over the pipe in layers not more than 6 inches thick, loose measurement, wetted to optimum moisture content and uniformly compacted to at least 95 percent of the maximum density obtainable at optimum moisture content as determined by AASHTO T99 Method A or D (latest revision), until the pipe has a cover depth of at least 12 inches.

3. Remainder of Trench Backfill:
 - a. The remaining depth of the trench shall be backfilled to existing finish grade, with excavation material removed from the trench, which shall be wetted or dried to near optimum moisture content.
 - b. Contractor shall be required to repair any settling problems which occur in the trench locations for the duration of the warranty period.
- G. Pipe fittings
 1. All piping 3" diameter or greater shall use "Leemco" ductile iron push on type fittings. Provide "Leemco" joint restraints at all gasket fittings where change of direction occurs. See drawings for details.
 2. All piping less than 3" diameter shall use Schedule 40 socket type fittings.

3.8 VALVE APPLICATIONS

- A. Rain Bird PESB-R with PRS-Dial pressure regulating module, size per plans.

3.9 VALVE INSTALLATION

- A. Valves: Install underground valves in valve boxes as shown on Drawings.
- B. Control Valves: Install in valve control valve boxes, arranged for easy adjustment and removal. Install union on downstream side. Maximum (1) valve per valve box.
- C. Place 6 inches minimum of gravel below control valves for drainage. Maintain 4 inches minimum between bottom of valves and top of gravel. Place filter fabric barrier between gravel and valves. Valve box shall be free of dirt and debris.

3.10 SPRINKLER INSTALLATION

- A. Sprinklers: Flush circuit piping with full head of water and install sprinklers after hydrostatic test is completed.
 1. Install lawn sprinklers at manufacturer's recommended heights.
 2. Install shrubbery sprinklers at heights indicated.
 3. Locate part-circle sprinklers to maintain a minimum distance of 12 inches from walls and 2 inches (50 mm) from other boundaries, unless otherwise indicated.
 4. Sprinkler Head Risers: Rotor pop-up sprinkler shall have an adjustable riser assembly (triple swing joint Rain Bird SA Series or approved equal). Stationary spray pop-up heads or shrubs spray heads shall have an adjustable riser assembly (triple swing joint) or low-density polyethylene flex pipe as shown on Drawings details. Triple swing joint fittings shall be of Schedule 80 PVC. Flex pipe shall be 12 inch long minimum and 18 inch maximum linear low-density polyethylene pipe with spiral barb fittings and 90 degree ell as shown on details on Drawing.
 5. Quick coupling valves shall be installed with an adjustable riser assembly (triple swing joint) and a Leemco quick coupler stabilizer, size as necessary.

3.11 AUTOMATIC CONTROL SYSTEM INSTALLATION

- A. Install controllers and controller pedestal according to manufacturer's written instructions and as indicated.
- B. Install control wiring in same trench with piping. Where wiring leaves from piping trenches, install wiring in conduits.
- C. Install control wiring in accordance with Specifications. Provide 10 inches expansion coil At each valve to which controls are connected, and at 100 foot intervals. Bury wire beside mainline pipe. Where wire leaves pipe, enclose in conduit. Use waterproof wire

connectors. Use white or gray color for common wires and black or red colors for all other wires. No control wires shall be placed in thrust blocks. Locate wires on opposite side of thrust blocks.

3.12 TRENCHING

- A. Trench Size:
 - 1. Minimum Depth: as necessary to provide 18" of cover for mainline, sleeves, and wires.
 - 2. Minimum Depth: as necessary to provide 12" of cover for all lateral lines..
 - 3. Minimum Width: 4 inch pipe and larger – 12 inches.
 - 4. Minimum Width: 3 inch pipe and smaller – 9 inches.
- B. Trench to accommodate grade changes and slope to drains.
- C. Maintain trenches free of debris, material, or obstructions that may damage pipe.

3.13 CONNECTIONS

- A. Connect piping to sprinklers, devices, valves, control valves, specialties, and accessories.
- B. Connect water supplies to irrigation systems. Include reduced pressure back-flow preventers on potable water supplies.
- C. Electrical Connections: Connect to power source, controllers, and automatic control valves.

3.14 FIELD QUALITY CONTROL

- A. Testing: Perform test of piping and valves before back-filling trenches. Piping may be tested in sections to expedite work. Owner's representative must be present for testing.
 - 1. Make all necessary provisions for thoroughly bleeding the line of air and debris.
 - 2. Before testing, fill the line with water for a period of at least 24 hours.
 - 3. **After valves have been installed, test all live water lines for leaks at a pressure of 100 psi for a period of one hour, with all couplings exposed and with all pipe sections center loaded.**
 - 4. Furnish all necessary testing equipment and personnel.
 - 5. Correct all leaks and retest until acceptance by the Landscape Architect.
- B. Field inspection and testing will be performed under provisions of Division 1.
- C. Installer's Field Service
 - 1. Prepare and start systems under provisions of Division 1.
 - 2. Provide one complete spring start-up and a fall shutdown, including winterization to blow out entire system with compressed air.
- D. Adjust work under provisions of Division 1.
- C. Change and/or adjust head types for full water coverage as directed.
- D. Adjust nozzle spray pattern as required to avoid water spray on building walls, roads or sidewalks.
- E. Have all backflow preventers tested by appropriate agency.

3.15 CLEANING AND ADJUSTING

- A. Flush dirt and debris from piping before installing sprinklers and other devices.
- B. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.
- C. Carefully adjust lawn sprinklers so they will be flush with, or not more than 2 inch (13 mm) above, finish grade after completion of landscape work. Adjust so that sprinklers do not spray on buildings or walls.

- D. Adjust settings of controllers and automatic control valves to insure proper watering of all landscaping.

3.16 COMMISSIONING

- A. Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturers, proceed as follows:
 - 1. Verify that specialty valves and their accessories have been installed correctly and operate correctly.
 - 2. Verify that specified tests of piping are complete.
 - 3. Check that sprinklers and devices are correct type.
 - 4. Check that damaged sprinklers and devices have been replaced with new materials.
 - 5. Check that potable water supplies have correct type back-flow preventers.
 - 6. Energize circuits to electrical equipment and devices.
 - 7. Adjust operating controls.
- B. Operational Testing: Perform operational testing after hydrostatic testing is completed, backfill is in place, and sprinklers are adjusted to final position.

3.17 DEMONSTRATION

- A. Provide irrigation system demonstration under provisions of Division 1.
- B. Demonstrate to Owner: that system meets coverage requirements and that automatic control functions properly.
- C. Demonstrate to Owner's maintenance personnel operation of equipment, sprinklers, specialties, and accessories. Review operating and maintenance information including start up and winterization procedures.
- D. Provide 7 days written notice in advance of demonstration.

END OF SECTION 328400

SECTION 328500 - LANDSCAPE GRADING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Final grade topsoil for finish landscaping.
- B. Related Sections
 - 1. Specification Section 311000: Site Clearing.
 - 2. Specification Section 312000: Earthmoving

1.2 SUBMITTALS

- A. Submit under provisions of Division 1.

1.4 QUALITY ASSURANCE

- A. Provide analysis of existing and imported topsoil fill under provisions of Division 1.
- B. Topsoil Analysis: Furnish a soil analysis if existing and imported topsoil made by a qualified independent soil-testing agency stating percentages of organic matter, inorganic matter (silt, clay and sand), deleterious material, pH, and mineral and plant-nutrient content of topsoil.
- C. Report suitability of topsoil for growth of applicable planting material. Contractor shall state in writing the recommended quantities of nitrogen, phosphorus, and potash nutrients and any limestone, aluminum, sulfate, or other soil amendments to be added to produce topsoil meeting the requirements listed in this section. Soil amendment quantities are called out in Sections 329200 and 329300 but are for bid purposes only. The results of the soils tests as reviewed by the Landscape Architect determine the proper amendments.
- D. All finish grades shall be approved by Landscape Architect prior to landscape installation.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS - NOT USED.
- 2.2 MATERIALS – NOT USED
- 2.3 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, 4% organic material minimum, free of stones 1 inch (25mm) or larger in any dimension, and other extraneous materials harmful to plant growth.
 - 1. Existing Topsoil Source: Reuse surface topsoil stockpiled on the site. Verify suitability of surface soil to produce topsoil meeting requirements and amend when necessary. Approved by Landscape Architect. Supplement with imported topsoil when quantities are insufficient. Clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - 2. Imported Topsoil Source: Import topsoil from off-site sources. Provide new topsoil that is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 1 inch in any dimension, and other extraneous or toxic matter harmful to plant growth.
 - a. Obtain topsoil from local sources or from areas having similar soil

characteristics to that found at project site. Obtain topsoil only from naturally, well-drained site where topsoil occurs in a depth of not less than four inches. Do not obtain from bogs or marshes.

- b. Representative samples shall be tested for acidity, fertility and general texture by a recognized commercial or government agency and copies of the testing agency's findings and recommendations shall be furnished to the Architect's representative by the contractor. No topsoil shall be delivered in a frozen or muddy condition. Acidity/alkalinity range – pH 5.5 to 7.6.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify trench backfilling have been inspected.
- B. Verify substrate base has been contoured and compacted and topsoil has been placed to design grades per the plans.
- C. Beginning work of this section means acceptance of rough grading, topsoil placement, and existing conditions.

3.2 PREPARATION

- A. Substrate
 - 1. Eliminate uneven areas and low spots.
 - 2. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove subsoil contaminated with petroleum products.
 - 3. Scarify subsurface to depth of 6 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil. Scarify on multiple passes in intersecting directions to break up, cut and mix subsurface to provide a homogenous mixture.

3.3 EXECUTION

- A. Place topsoil in areas where required to obtain thickness as scheduled. Place topsoil during dry weather.
- B. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.
- C. Finish grade of lawn or plant bed areas prior to planting shall be:
 - 1. Seeded Areas – 3/4 inch below top of adjacent pavement of any kind.
 - 2. Sodding Areas – 1½ inch below top of adjacent pavement of any kind.
 - 3. Planter Bed Areas - 3 inches below top of adjacent pavement of any kind.
- D. Remove roots, weeds, rocks, and foreign material while spreading, and remove from site.
- E. Manually spread topsoil close to plant life and paving to prevent damage.
- F. Lightly compact placed topsoil.
- G. Remove surplus subsoil and topsoil from site.
- H. Leave site clean and raked, ready to receive landscaping.
- I. Tolerances
 - 1. Top of Topsoil: Plus or minus ½ inch.

3.4 FIELD QUALITY CONTROL - NOT USED.

3.5 ADJUSTING - NOT USED.

3.6 CLEANING - NOT USED.

3.7 DEMONSTRATION - NOT USED.

3.8 PROTECTION

- A. Protect landscaping and other features remaining as final work.
- B. Protect existing structures, fences, sidewalks, and paving.

3.9 SCHEDULES

- A. Compacted topsoil thickness at the following areas:
 - 1. Planter Beds: 18 inches.

END OF SECTION 328500

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Seeding.
 - 2. Hydroseeding.
 - 3. Erosion-control material(s).

- B. Related Sections:

- 1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
 - 3. Division 32 Section "Planting Irrigation " for turf irrigation.
 - 4. Division 32 Section "Plants" for border edgings.

- C. References:

- 1. FS O-F-241 - Fertilizers, Mixed, Commercial.
 - 2. ASPA (American Sod Producers Association) - Guideline Specifications to Sodding.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.
- J. Topsoil: Per specifications section 328500.
- K. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, Brome Grass, Black Henbane, Buffalobur, Common Crupina, Dalmatian Toadflax, Diffuse Knapweed, Dyer's Woad, Eurasian Watermilfoil, Field Bindweed, Hoary Cress, joined Goatgrass, Leafy Spurge, Matgrass, Meadow Hawkweed, Meadow Knapweed, Milium, Musk Thistle, Orange Hawkweed, Perennial Pepperweed, Perennial Sowthistle, Poison Hemlock, Puncturevine, Purple Loosestrife, Russian Knapweed, Scotch Broom, Scotch Thistle, Silverleaf Nightshade, Skeletonleaf Bursage, Spotted Knapweed, Syrian Beancaper, Toothed Spurge, Yellow Starthistle, Yellow Toadflax.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.
- C. Submit sod certification for grass species and location of sod source.
- D. Qualification Data: For qualified landscape Installer.
- E. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- F. Material Test Reports: For existing native surface topsoil and imported or manufactured topsoil.

- G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Include cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer and herbicide. Submit before expiration of required initial maintenance periods.
- H. Seed Tabs: One tag for each seed mix used with date(s) of application.
- I. Fertilizer Labels: One label for each mix with date(s) of applications.
- J. Hydro-mulch Labels: One label with date(s) of application.
- K. Hydro-mulch Tackifier Labels: One label with date(s) of application.
- L. Soil Amendment samples.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Company specializing in manufacturing products specified in this section, with not less than three (3) years of documented experience.
- B. Installer Qualifications **(To be provide at time of bid opening)**: A qualified landscape Installer whose work has resulted in successful turf and meadow establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Company specializing in performing the work of this section with minimum five (5) years of documented experience and experience in the installation of a minimum of three (3) projects of similar nature and scope in addition to requirements in Division 01 Section "Quality Requirements.". The installer shall have at least one supervisor responsible for the project who is a Certified Landscape Technician as recognized by the Associated Landscape Contractors of America. The installer may be asked to provide references for verification of experience and quality of service.
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time English speaking supervisor on Project site when seeding/sodding work is in progress.
 - 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.
 - b. Certified Turfgrass Professional, designated CTP.
 - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
- C. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- D. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a Certified Professional Soil Scientist and qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Landscape Architect. A minimum of four representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

E. Preinstallation Conference: Conduct conference at Project site.

F. Obtain materials from same source throughout.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable. The label shall show the variety of seed, the percentage of germination, purity and weed content.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
- C. Bulk Materials:
 1. Do not dump or store bulk materials near drainage facilities, structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.7 PROJECT CONDITIONS

- A. Planting Restrictions: Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

- B. Planting Season: Seeding shall be accomplished in the fall prior to September 15th. If this is not accomplished, seeding shall be in the following spring after April 15.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.8 SEQUENCING AND SCHEDULING

- A. Coordinate work under provisions of Division 1.
- B. Coordinate with installation of underground sprinkler system.

1.9 EXTENDED WARRANTY

- A. Provide one year warranty under provisions of Division 1. Warranty includes coverage for one continuous growing season; replace lawn (seed or sod) that is dead, unhealthy or in an unsightly condition.

1.10 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
 - 1. Seeded Turf: 60 days from date of Substantial Completion of entire project.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
 - b. Seeded turf areas will not be accepted as substantial completion until a healthy, full, uniform stand of grass with no bare spots has been obtained.
 - 2. Sodded Turf: 60 days from date of Substantial Completion of entire project.
- B. Initial Dryland Grass Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 60 days from date of Substantial Completion.
- C. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
 - 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

2. Apply herbicides to control weed growth in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- D. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.
 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water lawn at a minimum rate of 1½ inch per week.
- E. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 30 percent of grass height. Remove no more than 30 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Remove excess clippings after mowing. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the grass height at 2.5 inches
- F. Lawn Fertilization: Apply fertilizer at intervals specified.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species as follows:
- C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 1. Sun and Partial Shade: (Turf saver® with RTF® as available through The Turf Company, 6100 S. Eagle Road, Meridian, Idaho, 83642, (208)888-3760, contact Aubrey Gray.) or approved equal.
Proportioned by weight as follows:
 - a. 40% Labarinth (RTF) Tall Fescue
 - b. 30% Barrera Tall Fescue
 - c. 30% Barlexas II Tall Fescue
 2. Seed shall be provided from and mixed by a certified dealer. Seed mixture shall be labeled with manufacturer's guaranteed analysis, germination rate and purity rate.
 3. Apply at manufacturer's recommended application rate.

2.2 TURF GRASS SOD

- A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Sun and Partial Shade: (Turf saver® with RTF® as available through The Turf Company, 6100 S. Eagle Road, Meridian, Idaho, 83642, (208)888-3760, contact Aubrey Gray.) or approved equal.
Proportioned by weight as follows:
 - a. 40% Labarinth (RTF) Tall Fescue
 - b. 30% Barrera Tall Fescue
 - c. 30% Barlexas II Tall Fescue

2.3 DRYLAND SEED

- A. Grass Seed: Install at 25 lbs / acre. Fresh, clean, pure live, and dry new seed, of mixed species as follows:
 1. 7.6% Bluebunch Wheatgrass
 2. 9.8% Thickspike Wheatgrass
 3. 9.45% Ephraim Wheatgrass
 4. 5.3% Covar Sheep Fescue
 5. 9.0% Thurber Needle Grass
 6. 9.0% Great Basin Wild rye
 7. 6.3% Indian Rice Grass
 8. 5.25% Western Yarrow
 9. 5.0% Canby Bluegrass
 10. 5.3% Lewis Blue flax
 11. 9.0% Sainfoin
 12. 2.0% Farewell To Spring
 13. 17.0% Steptoe Barley
- B. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.4 SOIL AMENDMENTS

- A. Gro-Power Plus or approved equal. (Apply at 150 lbs per 1000 sq. ft. or submit manufacturer's recommendation for approval) Humus (bacteria included based fertilizer and soil conditioner with soil penetrant shall consist of the following percents by weight:
 - 5% nitrogen
 - 3% phosphoric acid
 - 1% potash
 - 50% humus
 - 15% humic acids
- B. Compost: (Apply at 3 cu. yds. per 1000 sq. ft.) Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 1. Organic Matter Content: 50 to 60 percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

2.5 FERTILIZERS

- A. Commercial Slow Release Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
 2. Initial Application (two weeks after seeding, assumes fall planting) at 5 lbs/1000 sq. ft:
 - a. 16 percent Nitrogen.
 - b. 16 percent Phosphorus.
 - c. 16 percent Potassium.
 - d. Micronutrients
 - e. 60 percent slow release nitrogen.
 3. Spring Fertilization: (April 1) at 7 lbs/1000 sq. ft.
 - a. 30 percent Nitrogen.
 - b. 6 percent Phosphorus.
 - c. 12 percent Potassium
 - d. 50 percent slow release nitrogen.
 4. Summer Application: (June 1) at 7 lbs/1000 sq. ft.
 - a. 30 percent Nitrogen.
 - b. 6 percent Phosphorus.
 - c. 12 percent Potassium
 - d. 50 percent slow release nitrogen.
 5. Fall Application: (August 15) at 7 lbs/1000 sq. ft.
 - a. 18 percent Nitrogen.
 - b. 3 percent Phosphorus.
 - c. 18 percent Potassium
 - d. 50 percent slow release nitrogen.

2.6 PLANTING SOILS

- A. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones **1 inch** or larger in any dimension and other extraneous materials harmful to plant growth. Mix ASTM D 5268 topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
1. Gro-Power Plus or approved equal at 200 lbs per 1000 sq. ft.
 2. Weight of Compost per 1000 sq. ft.: 3 cu. yds.
 3. Weight of Sulfur per **1000 Sq. Ft.**: 10 lbs.
 4. Weight of Commercial Fertilizer per **1000 Sq. Ft.**: 5lbs per 1000 sq. ft.
- B. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least **4 inches** deep; do not obtain from bogs or marshes.
1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones **1/2 inch** or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy,

nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2.7 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.8 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.
- D. Weed Abatement: "Round-up" (contact herbicide) by Monsanto, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
5. Verify that prepared topsoil is ready to receive the work of this Section.
6. Beginning of installation means acceptance of existing site conditions.
7. All planting areas shall be weed free at the time of seed or sod installation.
8. Soil Tests: Per Landscape Grading specification section 328500. Prior to planting, amendments shall be added to correct for problems as noted by the soils report.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.2 WEED ABATEMENT

- A. All areas to be planted or hydroseeded shall have weed abatement operations performed on them prior to planting or hydroseeding.
- B. Contractor shall spray all exposed weeds with "Round-up" (contact herbicide) or approved equal.
- C. Do not water for at least seven (7) days. Remove exposed weeds from the site.
- D. Contractor shall operate the automatic irrigation system for a period of fourteen (14) days. At conclusion of this watering period, discontinue watering for three to five (3-5) days.
- E. Apply second application of "Round-up" to all exposed weeds. Apply in strict conformance with manufacturer's specifications and instructions. Do not water for at least seven (7) days. Remove weeds from the site.
- F. If any evidence of weed germination exists after two (2) applications, Contractor shall be directed to perform a third application.
- G. At the time of planting and hydroseeding, all planting areas shall be weed free.

3.3 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.4 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Spread planting soil to a depth of 9 inches in turf areas and 18 inches at shrub bed areas but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread planting soil over loosened subgrade.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Loosen surface soil to a depth of at least 6 inches. Provide weed abatement procedure. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Apply soil amendments directly to surface soil before loosening.
 - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- G. Do not sow immediately following rain, or when ground is too dry. Temperature shall be between 55 F and 95 F for a 24 hour period. Wind shall be less than 5 mph.
- H. Turf Seed shall be sown at a rate per seed supplier recommendations.
- I. Seed shall be hydroseeded or drill seeded at the contractors option. Areas with a 4:1 or greater slope shall be hydroseeded.

3.5 DRILL SEEDING

- A. Sow seed with cultipacker (“Brillion” equipment or equal), seeding machine, or approved similar equipment to drill, cover and firm the seed bed in one operation. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other. Apply water with a fine spray immediately after each area has been seeded. Saturate the top 4 inches of soil.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 2. Do not seed against existing trees.
 - 3. Keep soil surface continuously damp.
- B. Protect seeded areas with slopes exceeding 1:4 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

3.6 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application. Slopes in excess of 4 horizontal to 1 vertical shall be hydroseeded.
 - 1. Mix slurry with nonasphaltic tackifier.
 - 2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than **1500-lb/acre** dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.7 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. Moisten prepared surface immediately prior to laying sod.
 - 2. Lay sod immediately after delivery to site to prevent deterioration.
 - 3. Lay sod across angle (perpendicular) of slopes exceeding 1:3.
 - 4. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
 - 5. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

- C. Saturate sod with fine water spray immediately after planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of **1-1/2 inches** below sod.

3.8 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of **4 inches**.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water turf with fine spray at a minimum rate of **1 inch** per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Mow Kentucky bluegrass annual ryegrass chewings red fescue to a height of **2 inches**.
- D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 - 1. Apply fertilizer in accordance with manufacturer's instructions.
 - 2. Lightly water to aid the dissipation of fertilizer.
 - 3. Sweep all hard surfaces of fertilizer overthrow.
 - 4. Turf areas seeded months ahead of acceptance of the entire project will be fertilized on an eight to ten week schedule consistent with the seasonal period and application rates specified.

3.9 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Landscape Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 98 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
 3. All turf areas will be accepted at the same time, including all phased areas.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. All scars, ruts or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. Contractor shall pick up all trash resulting from this work no less frequently than each Friday before leaving the site, once a week, and/or the last working day of each week. All trash shall be removed completely from the site. The Contractor shall leave the site area broom-clean and shall wash down all paved areas within the Contract area, leaving the premises in a clean condition acceptable to the Owner and Construction Manager.
- C. Erect temporary fencing or barricades and warning signs to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Plants.
 - 2. Planting soils.
 - 3. Tree stabilization.
 - 4. Landscape edgings.

- B. Related Sections:

- 1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
 - 2. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
 - 3. Division 32 Section "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
- D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- E. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

- F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- G. Finish Grade: Elevation of finished surface of planting soil.
- H. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- I. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- J. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- K. Planting Area: Areas to be planted.
- L. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- M. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- N. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- O. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- P. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- Q. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- R. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, including soils.
- B. Samples for Verification: For each of the following:
 - 1. Certificates required by law that accompany shipments.

2. Bark Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
 3. Compost Material: One gallon Ziploc bag with sample name, product material, including testing information.
 4. Weed Control Barrier: 12 by 12 inches.
 5. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
 6. Root Barrier: Width of panel by 12 inches.
- C. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
1. Manufacturer's certified analysis of standard products.
 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.
- F. Warranty: Sample of special warranty.
- G. Submit list of plant life sources, size and quality.
1. Substitutions: Submit list of plant life sources, size, quality and plants being recommended for substitution. Substitutions will not be approved unless non-availability can be demonstrated.
- H. Project Record Documents:
1. Record plant locations, including substitutions, and quantities.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications (To be provide at time of bid opening):** A qualified landscape Installer whose work has resulted in successful establishment of plants.
1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 2. Experience: Five years' experience in landscape installation in addition to requirements in Division 01 Section "Quality Requirements."
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

- a. Certified Landscape Technician - Exterior, with installation or irrigation specialty area(s), designated CLT-Exterior.
- b. Certified Ornamental Landscape Professional, designated COLP.

5. Pesticide Applicator: State licensed, commercial.

- B. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 3. Report suitability of tested soil for plant growth.
 - a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- E. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- F. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.
- G. Preinstallation Conference: Conduct conference at project site.
- H. Tree Pruning/Maintenance: ASNI A300 – American National Standard for Tree Care Operations – Tree, Shrub and Other Wood Plant Maintenance Standard Practices.
- I. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.

1.6 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for compost material composition.
- B. Comply with regulatory agencies for fertilizer and herbicide composition.
- C. Plant Materials: Certified by federal department of agriculture; free of disease or hazardous insects.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
- B. Bulk Materials:
 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
- C. Deliver plants freshly dug.
- D. Do not prune trees and shrubs before delivery, except as approved by Landscape Architect. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- E. Handle planting stock by root ball.
- F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 2. Do not remove container-grown stock from containers before time of planting.
 3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.
- G. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
- H. Deliver all plant material to the site in their original containers with labels intact and legible at the time of inspection.
- I. Remove from the site all plants that are not true to name and all materials that do not comply with the provisions of this section.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
1. Notify Architect no fewer than two days in advance of proposed interruption of each service or utility.
 2. Do not proceed with interruption of services or utilities without Architect's written permission.
- C. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
- D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise acceptable to Landscape Architect.
1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.
 2. Ensure proper irrigation coverage for plant watering.

1.9 WARRANTY

- A. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond Contractor's control.
 - 1. Warranty Period for Trees and Shrubs: One year from date of Substantial Completion.
 - 2. Warranty Period for Ground Cover: Twelve (12) months from date of Substantial Completion. When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.
 - 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
 - d. One (1) year warranty walk-through to review status of plants with Owner and Landscape Architect.

1.10 MAINTENANCE SERVICE

- A. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
 - 1. Maintenance Period: One month from date of Substantial Completion.
- B. Initial Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
 - 1. Maintenance Period: One month from date of Substantial Completion.
- C. Removal of tree stakes after one (1) year warranty walk-through is complete.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings

and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than **3/4 inch** in diameter; or with stem girdling roots will be rejected.
 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.
- E. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through **3/4-inch** sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: 50 to 60 percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.3 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
 - 1. Product: Agriform 20-10-5, or approved equal.
 - 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.4 PLANTING SOIL MIX

- A. Planting Soil Mix: Mix topsoil with the following soil amendments and fertilizers in the following quantities:
 - 1. Ratio of Loose Compost to Topsoil by Volume: 1:5.
- B. Additional Amendments:
 - 1. Fertilizer Tablets:
 - a. Three (3) tablets for shrubs
 - b. Eight (8) tablets for trees.

2.5 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
 - 1. Type: Wood and bark chips.
 - 2. Size Range: 1 inches maximum, 1 inch minimum.
 - 3. Color: Natural.

2.6 WEED-CONTROL BARRIERS

- A. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd..

2.7 PESTICIDES

- A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

2.8 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood or softwood with specified wood pressure-preservative treatment, free of knots, holes, cross grain, and other defects, **2-by-2-inch nominal** by length indicated, pointed at one end.
2. Flags: Standard surveyor's plastic flagging tape, white, **6 inches** long.
3. Proprietary Staking-and-Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by plant stem; sized as indicated and per manufacturer's written recommendations.
 - a. Products: Subject to compliance with requirements, provide the following or approved equal:
 - 1) Arborbrace; ArborBrace Tree Guying System.

2.9 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Planter Filter Fabric: Woven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.
- E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING AREA ESTABLISHMENT

- A. Loosen subgrade of planting areas to a minimum depth of **4 inches**. Remove stones larger than **1/2 inches** in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
 - 2. Spread planting soil to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
- B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter for stock.
 2. Excavate at least equal width of rootball.
 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 5. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 6. Maintain supervision of excavations during working hours.
 7. Keep excavations covered or otherwise protected after working hours or when unattended by Installer's personnel.
- B. Subsoil and topsoil removed from excavations may be used as planting soil.
- C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
1. Hardpan Layer: Drill **6-inch-** diameter holes, **24 inches** apart, into free-draining strata or to a depth of **10 feet**, whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. **Remove all burlap and wire baskets from root balls. Remove all nails, ties, and plastic from the trunk and root ball.** Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
- C. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- D. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare **1 inch** above adjacent finish grades.
1. Use planting soil for backfill.
 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about **1 inch** from root tips; do not place tablets in bottom of the hole.
 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- E. Set container-grown stock plumb and in center of planting pit or trench with root flare **1 inch** above adjacent finish grades.
1. Use planting soil for backfill.
 2. Carefully remove root ball from container without damaging root ball or plant.
 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about **1 inch** from root tips; do not place tablets in bottom of the hole. Place mycorrhizal fungal transplant inoculant in doughnut shape around rootball.
 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- F. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices, see ASNI-A300, Paragraph 5.4.1 Young Tree Pruning at Planting. Unless otherwise indicated by Landscape Architect, **do not cut tree leaders**; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

- A. Install trunk stabilization as follows unless otherwise indicated:
 1. Upright Staking and Tying: Stake trees of **2- through 5-inch** caliper. Stake trees of less than **2-inch** caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least **18 inches** below bottom of backfilled excavation and to extend to the dimension shown on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.

2. Use two stakes for trees up to 12 feet high and 3 inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
4. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.8 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on drawings in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING AREA MULCHING

- A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches and secure seams with galvanized pins.
- B. Mulch backfilled surfaces of planting areas and other areas indicated.
 1. Trees in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
 2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.10 EDGING INSTALLATION

- A. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4- to 6-inch- deep, shovel-cut edge as shown on Drawings.

3.11 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.13 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.14 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 329300

SECTION 331100 - SITE WATER LINES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. On and Offsite water main and service including piping, fittings, meter, accessories and bedding to 5' from building.

1.2 REFERENCES

- A. ASTM D 1785 - Specification for Poly (Vinyl Chloride) PVC Plastic Pipe, Schedules 40, 80 and 120.
- B. ASTM D 2855 - Practice for making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- C. AWWA C-900 - PVC Pipe.
- D. AWWA C-601 - Standard for Disinfecting Water Mains.
- E. AWWA C-500 - Gate Valves.
- F. ISPWC - Idaho Standards for Public Works Construction, latest edition.
- G. ASTM A 575 - Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
- H. ASTM A 197 - Specification for Cupola Malleable Iron.
- I. NFPA - National Fire Protection Association.

1.3 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Shop Drawings: Indicate general installation, components, dimensions, coverage, clearances, and methods of installation.
- C. Field Reports: Indicate summary of Hydrostatic Test and Field Acceptance Tests performed in accordance with NFPA 20.
- D. Operation and Maintenance Data
 - 1. Submit under provisions of Division 1.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with the latest edition of the Idaho Rules for Public Drinking Water Systems, Idaho Standards for Public Works Construction, and local District Health Department.
- B. Qualifications
 - 1. Manufacturer: Company specializing in manufacture of the products specified in this Section with minimum five years experience.
 - 2. Installer: Company specializing in performing the work of this Section with minimum three years experience.
- C. Regulatory Requirements
 - 1. Plumbing Code Compliance: Comply with applicable portions of National Standard Plumbing Code pertaining to selection and installation of potable water system materials and products.
 - 2. Water Purveyor Compliance: Comply with requirements of Purveyor supplying water to project, obtain required permits and inspections.

3. Conform to applicable ASTM and AWWA specifications regarding installation of water lines.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 1.

- 1.6 PROJECT/SITE CONDITIONS - not used.
- 1.7 SEQUENCING AND SCHEDULING - not used.
- 1.8 EXTENDED WARRANTY - not used.
- 1.9 MAINTENANCE - not used.

PART 2 – PRODUCTS

- 2.1 MANUFACTURERS - not used.

2.2 MATERIALS

A. Pipes and Pipe Fittings

1. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in potable water systems. Where more than one type of materials or products are indicated, selection is Installer's option.
2. Piping: Provide pipes of one of the following materials, of weight/class indicated. Provide pipe fittings and accessories of same materials and weight/class as pipes, with joining method as indicated.
 - a. Class 200 psi Poly Ethylene pipe for 1" service piping.
 - b. Class 150 Polyvinyl Chloride (PVC) (AWWA C-900) SDR 18. Bell and spigot with rubber sealing ring for pipe 6" to 12" in diameter.
 - c. Class 52 cement-lined ductile pipe meeting ANSI/AWNA C151 for diameters of 6" to 64".

B. Valves

1. Gate Valves: Provide as indicated, resilient seated valves, AWWA C509-87, 175 psi working pressure and shall be Clow or Mueller A2360, with 2" square operating nuts with either flanged or mechanical joint. Provide threaded, flanged, hub, or other end configurations to suit size of valve and piping connection. Provide inside screw type for use with curb valve box, iron body, bronze-mounted, non-rising stem.

C. Fire Hydrants

1. Provide 200 psi Mueller Centurion fire hydrants with two coats of red hydrant enamel.
2. Provide Storz coupler on steamer port as manufactured by Red Head Brass or Angus Fire.
3. Per Idaho Standards for Public Works Construction Section 403.

D. Trench Fill Materials

1. Trench backfill: Type A backfill according to Idaho Standards for Public Works Construction Section 306.3.3.

- 2.3 MANUFACTURED UNITS - not used.
- 2.4 EQUIPMENT - not used.
- 2.5 COMPONENTS - not used.

2.6 ACCESSORIES

- A. Anchorages: Provide anchorages for tees wyes, crosses, plugs, caps, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages.
 - 1. Rods: Steel, ASTM A 575.
 - 2. Rod Couplings: Malleable-iron, ASTM A 197.
 - 3. Thrust Blocks: Concrete, 2,500 psi.
- B. Water Meter: Provide water meter and total assembly; read per gallons. Provide meter box, ring and cover. Installation shall conform with the ISPWC
- C. No.12 Direct Burial Locator wire with Dri-splice connectors shall be installed with waterlines. Wire shall extend to surface at all valve boxes/meters/fire hydrants and be placed at crown of pipe per Idaho Standards for Public Works Construction , latest edition, Section 401.

PART 3 - EXECUTION

- 3.1 EXAMINATION - not used.
- 3.2 PREPARATION - not used.

3.3 EXECUTION

- A. Install in accordance with the Manufacturer's instructions, only after shop drawings have been approved.
- B. Route pipe in straight lines.
- C. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- D. Install access fitting to permit disinfection of water system.
- E. Form and place concrete for thrust blocks at each change of direction of pipe main.
- F. Establish elevations of buried piping to ensure not less than 4'-0" of cover.
- G. Set valves on solid bearing. Locate valve a minimum of 12" away from hydrant.
- H. Center and plumb valve box over valve. Set box cover flush with finished grade.
- I. Center and plumb valve box over valve. Set box cover flush with finished grade.
- J. Paint hydrant in accordance with City of Boise Fire Department.

3.4 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with the Idaho Standards for Public Works Construction, latest edition.
- B. Compaction Testing, 1 per 100 lin. ft., 2 per lift.
- C. Pressure test entire system in accordance with the Idaho Standards for Public Works Construction, latest edition, after backfilling and compacting of the trenches.
- D. Test shall be witnessed and approved by the Engineer of Record and the City of Boise personnel or their representatives.
- E. Disinfect water mains in accordance with requirements of AWWA C-601, Section 401 of the Idaho Standards for Public Works Construction, latest edition.

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- 3.5 ADJUSTING - not used.
- 3.6 CLEANING - not used.
- 3.7 DEMONSTRATION - not used.
- 3.8 PROTECTION - not used.
- 3.9 SCHEDULES - not used.

END OF SECTION 330510

SECTION 333100 - SITE SANITARY SEWERAGE SYSTEM

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Sanitary sewerage piping, fittings, accessories and bedding.
- B. Connection of building sanitary system to public sanitary sewer system.

1.2 REFERENCES

- A. ASTM D 1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- B. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- C. ASTM D 1785 - Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
- D. ASTM D 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- E. ASTM D 3017- Test Methods for Water Content of Soil and Rock in Place by Nuclear Methods.
- F. ISPWC – Idaho Standards for Public Works Construction – current edition.
- G. SD – Standard drawing from ISPWC.
- H. Definitions
 - 1. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.3 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Product Data: Provide data indicating pipe, pipe accessories, and fill material.
- C. Project Record Documents
 - 1. Submit documents under provisions of Division 1.
 - 2. Record location of pipe runs, connections, cleanouts and invert elevations.
 - 3. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements
 - 1. Conform to Idaho Standards for Public Works Construction, local District Health Department and City of Boise requirements.

1.5 DELIVERY, STORAGE AND HANDLING - not used.

1.6 PROJECT/SITE CONDITIONS

- A. Verify that field measurements and elevations are as indicated.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate work under provisions of Division 1.
- B. Coordinate the Work with termination of sanitary sewer connection outside building, and trenching.

1.8 EXTENDED WARRANTY - not used.

1.9 MAINTENANCE - not used.

PART 2 – PRODUCTS

2.1 MANUFACTURERS - not used.

2.2 MATERIALS

A. Sewer Pipe

1. Pipe: ASTM D3034, SDR 35, Type PSM, Poly Vinyl Chloride (PVC) material; inside nominal diameter as indicated, bell and spigot style gasket sealed joint end.

B. Sewer Service Connection

1. Service Connection Tee or Wyes Fittings
 - a. Tees or Wyes: Consistent with main and service lines.
 - b. Fasteners: All clamps, straps, nuts, bolts and washers to be solid stainless steel.
 - c. Tee Fittings: Inserta-Tee, Insta-tap, Kor-N-Tee or approved substitution.
2. Service Saddle Connections:
 - a. Saddles: Romac "CB", Fernco EZ tap, *Saddle by NDS*, or approved substitution.

C. Bedding Materials

1. Aggregate Bedding: Fill Type A as specified in Section 312300.
2. Trench Backfill: Fill from pipe bedding to subgrade per Section 312500.

D. Concrete and Reinforcement

1. Concrete: Portland cement mix, 3,000 psi
 - a. Cement: ASTM C 150, Type II.
 - b. Fine Aggregate: ASTM C 33, sand.

E. Per City of **Boise** requirements.

2.3 MANUFACTURED UNITS - not used.

2.4 EQUIPMENT - not used.

2.5 COMPONENTS

A. Cleanouts

1. General: Provide cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy duty, secured scoriated cast-iron cover per ISPWC standard drawing (SD-506).

B. Manholes

1. Pre-cast Concrete Manholes: ASTM C 478, pre-cast reinforced concrete, of dimensions with appurtenances indicated on the drawings, with provision for rubber gasket joints manufactured by Amcor or approved equivalent.
 - a. Base Section: 6 inch minimum thickness for floor slab and 4 inch minimum thickness for walls and base riser section, and having a separate base slab or base section with integral floor.
 - b. Rise Sections: 4 inch minimum thickness, 48 inch diameter and lengths to provide depth indicated.
 - c. Top Section: Eccentric cone type, unless concentric cone or flat-slab-top type is indicated. Top of cone to match grade rings.
 - d. Grade Rings: Provide reinforced concrete rings, of 6 to 21 inches total thickness and match 24-inch diameter frame and cover.
 - e. Gaskets: ASTM C 433, rubber.
 - f. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
 - g. Channel and Bench: Concrete.

2. Manhole Frames and Covers: ASTM A 536, Grade 6-40-18, heavy-duty, ductile iron, 24-inch inside diameter by 7 to 9 inch riser with 4 inch minimum width flange, and 26 inch diameter cover, having small square or short slotted drainage openings.
3. Per Idaho Standards for Public Works Construction SD-501.
- C. Sewer Grease Trap:
 1. Per Mechanical Specifications.
- 2.6 ACCESSORIES
 - A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations.
 - B. Pipe Joints: Neoprene ribbed gasket for positive seal.
- 2.7 MIXES - not used.
- 2.8 FABRICATION - not used.
- 2.9 SOURCE QUALITY CONTROL - not used.

PART 3 - EXECUTION

- 3.1 EXAMINATION
 - A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.
- 3.2 PREPARATION
 - A. Hand trim excavations to required elevations. Correct over excavation with Type B aggregate.
 - B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.
- 3.3 EXECUTION
 - A. Bedding
 1. Excavate pipe trench in accordance with Section 312500 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
 2. Place bedding material in accordance with Section 312300 at trench bottom, level materials in continuous layer not exceeding 4 inches compacted depth, compact to a minimum of 95 percent.
 3. Maintain optimum moisture content of bedding material to attain required compaction density.
 - B. Pipe
 1. Install pipe, fittings, and accessories in accordance with ASTM D 2321, manufacturer's instructions. Seal joints watertight.
 2. Pipe installation and backfill shall be consistent with the latest edition of the ISPPWC.
 3. Lay pipe to slope at gradients noted on drawings; with maximum variation from true slope of 1/16 inch in 10 feet.
 4. Install bedding to minimum compacted thickness of 6" above pipe, 4" below pipe and 12" at sides of pipe; compacted to 95 percent.
 5. Refer to Section 312500 for trenching requirements. Do not displace or damage pipe when compacting.
 6. Connect to building sanitary sewer outlet and sewage treatment system.
 7. See attached drawings.
- 3.4 FIELD QUALITY CONTROL
 - A. Field inspection and testing will be performed under provisions of Division 1.
 - B. Request inspection prior to placing bedding.

- C. Compaction testing will be performed in accordance with ASTM D 1557.
 - D. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to owner.
 - E. Frequency of Tests: 1 per 100 lin. Foot, 2 per lift.
 - F. Prior to final acceptance, after all utilities are in and prior to paving, an air test shall be conducted. The contractor shall contact the City and the Engineer of Record a minimum of 24 hours prior to testing.
 - G. All stationing relates to the gravity sewer centerline.
- 3.5 ADJUSTING - not used.
- 3.6 CLEANING - not used.
- 3.7 DEMONSTRATION - not used
- 3.8 PROTECTION
- A. Protect finished installation under provisions of Division 1.
 - B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.
- 3.9 SCHEDULES - not used.
- 3.10 APPROVAL AND ACCEPTANCE:
- A. All Work to within 5' of the structure shall be done in accordance with the Idaho Standards for Public Works Construction (ISPWC) – latest edition.
 - B. All work is to be installed and tested per the Idaho Standards for Public Works Construction – latest edition.

END OF SECTION 330530

SECTION 334100 - STORM UTILITY DRAINAGE AND PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. REFERENCES

1. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
2. AASHTO M-252, 3 to 10 inch pipe, Specifications for Corrugated Polyethylene Pipe.
3. AASHTO M-294, 12" to 36" pipe, Specification for Corrugated Polyethylene Pipe.
4. ASTM C 478 - Specification for Pre-cast Reinforced Concrete Manhole Sections.
5. ASTM C 923 - Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Laterals.
6. ASTM C 443 - Specification for Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets.
7. ASTM F447 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.
8. ASTM C 150 - Specification for Portland Cement.
9. ASTM C 33 - Specification for Concrete Aggregates.
10. ASTM A 185 - Specification for Steel Welded Wire Fabric for Concrete Reinforcement.
11. ASTM 615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
12. ASTM A 536 - Specification for Ductile Iron Castings.
13. ASTM D 698 - Test Method for Moisture Density Relations of Soils and Soil-Aggregate Mixtures using 5.5 lb. (2.49 kg.) Rammer and 12 inch Drop.
14. ASTM D 1869 - Specification for Rubber Rings for Asbestos-Cement Pipe.
15. ASTM D 2321 - Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
16. ASTM C 891 - Practice for Installation of Underground Pre-cast Concrete Utility Structures.
17. ISPWC – Idaho Standards for Public Works Construction – current edition.

B. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Cleanouts.
4. Drains.
5. Channel drainage systems.
6. Catch basins.
7. Stormwater inlets.

8. Stormwater detention structures.
9. Pipe outlets.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

1.4 SUBMITTALS

- A. Product Data under provisions of Division 1: For each type of product indicated.
 1. Drainage conduits, including rated capacities.
 2. Drainage panels, including rated capacities.
 3. Geotextile filter fabrics.
 4. Shop drawings.
 5. Submit manufacturer's installation instructions under provisions of Division 1.
 6. Project Record Documents
 - a. Submit documents under provisions of Division 1.
 - b. Accurately record location of pipe runs, connections, catch basins, cleanouts, and invert elevations each day.
 - c. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities each day.
- B. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements
- B. Conform to Idaho Standards for Public Works Construction and the City of Boise codes for materials and installation of the Work of this Section.
 1. Comply with applicable portions of all environmental agency regulations pertaining to storm sewerage systems.
 2. Comply with ACHD requirements for all right-of-way improvements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

- D. Handle catch basins and storm water inlets according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Architect's written permission.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy classes.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.2 ABS PIPE AND FITTINGS

- A. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.
 - 1. NPS 3 to NPS 6: SDR 35.
 - 2. NPS 8 to NPS 12: SDR 42.
- B. Gaskets: ASTM F 477, elastomeric seals.

2.3 PE PIPE AND FITTINGS

- A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
 - 2. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
- B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
 - 2. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.4 PVC PIPE AND FITTINGS

A. PVC Cellular-Core Piping:

1. PVC Cellular-Core Pipe and Fittings: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
2. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.

B. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F 477, elastomeric seals.

2.5 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Unshielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco Inc.
 - c. Logan Clay Pipe.
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. NDS Inc.
 - f. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
3. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Shielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Cascade Waterworks Mfg.
 - b. Dallas Specialty & Mfg. Co.
 - c. Mission Rubber Company; a division of MCP Industries, Inc.

3. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

2.6 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.
 - d. Tyler Pipe.
 - e. Watts Water Technologies, Inc.
 - f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
3. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
4. Top-Loading Classification(s): Heavy Duty.
5. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.
3. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.7 DRAINS

A. Cast-Iron Area Drains:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.
 - d. Tyler Pipe.
 - e. Watts Water Technologies, Inc.
 - f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
3. Description: ASME A112.6.3 gray-iron round body with anchor flange and round secured grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated.
4. Top-Loading Classification(s): Medium and Heavy Duty.

2.8 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
 1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
- C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.9 CATCH BASINS

- A. Standard Precast Concrete Catch Basins:
 1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.

4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
 6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
 7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
 8. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- B. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.
1. Joint Sealants: ASTM C 990, bitumen or butyl rubber.
 2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
 3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
 4. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.
1. Size: 24 by 24 inches minimum unless otherwise indicated.
 2. Grate Free Area: Approximately 50 percent unless otherwise indicated.
- D. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings.
1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.10 PIPE OUTLETS

- A. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
1. Average Size: NSSGA No. R-3, screen opening 2 inches.
 2. Average Size: NSSGA No. R-4, screen opening 3 inches.
 3. Average Size: NSSGA No. R-5, screen opening 5 inches.
- B. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.
- C. Energy Dissipaters: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton average weight armor stone, unless otherwise indicated.

2.11 STORMWATER DISPOSAL SYSTEMS

A. Chamber Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Advanced Drainage Systems.
 - b. CULTEC, Inc.
 - c. Hancor Inc.
 - d. Infiltrator Systems, Inc.
 - e. StormTech LLC.
 - f. Oldcastle Precast.
3. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.
4. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch washed, crushed stone or gravel.
5. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of 4 oz./sq. yd..

B. Pipe Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252M for NPS 10 and smaller, AASHTO M 294M for NPS 12 to NPS 60. Include proprietary fittings, couplings, seals, and filter fabric.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Advanced Drainage Systems.
 - b. Hancor Inc.
 - c. NDS.

PART 3 - EXECUTION

3.1 EARTHWORK

- #### A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
 - 3. Install piping with 18 inch minimum cover.
 - 4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 6. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
 - 7. Install corrugated steel piping according to ASTM A 798/A 798M.
 - 8. Install corrugated aluminum piping according to ASTM B 788/B 788M.
 - 9. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
 - 10. Install PE corrugated sewer piping according to ASTM D 2321.
 - 11. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
 - 12. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
 - 13. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
 - 14. Install PVC water-service piping according to ASTM D 2321 and ASTM F 1668.
 - 15. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
 - 16. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
5. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
6. Join corrugated steel sewer piping according to ASTM A 798/A 798M.
7. Join corrugated aluminum sewer piping according to ASTM B 788/B 788M.
8. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
9. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
10. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
11. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
12. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
13. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
14. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
15. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
16. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
 2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
 3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
 4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1/2 inch above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN INSTALLATION

- A. Install type of drains in locations indicated.

1. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification drains in roads.

- B. Embed drains in 4-inch minimum concrete around bottom and sides.
- C. Fasten grates to drains if indicated.
- D. Set drain frames and covers with tops flush with pavement surface.
- E. Assemble trench sections with flanged joints.
- F. Embed trench sections in 4-inch minimum concrete around bottom and sides.

3.6 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.9 CHANNEL DRAINAGE SYSTEM INSTALLATION

- A. Install with top surfaces of components, except piping, flush with finished surface.
- B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
- C. Embed channel sections and drainage specialties in 4-inch minimum concrete around bottom and sides.
- D. Fasten grates to channel sections if indicated.

- E. Assemble channel sections with flanged or interlocking joints.
- F. Embed channel sections in 4-inch minimum concrete around bottom and sides.

3.10 STORMWATER DISPOSAL SYSTEM INSTALLATION

- A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill according to chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.
- B. Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, according to piping manufacturer's written instructions.

3.11 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."
- B. Connect force-main piping to building's storm drainage force mains specified in Division 22 Section "Facility Storm Drainage Piping." Terminate piping where indicated.
- C. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 - 4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

- D. Connect to sediment interceptors specified in Division 22 Section "Sanitary Waste Interceptors."
- E. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Unshielded flexible couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
 - 2. Use pressure-type pipe couplings for force-main joints.

3.12 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
 - 1. Remove manhole or structure and close open ends of remaining piping.
 - 2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Division 31 Section "Earth Moving."

3.13 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 - 1. Use warning tape or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.14 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.
 - c. Option: Test concrete piping according to ASTM C 924.
 - d. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.15 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 334100

SECTION 334600 - SUBDRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. REFERENCES

1. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
2. AASHTO M-252, 3 to 10 inch pipe, Specifications for Corrugated Polyethylene Pipe.
3. AASHTO M-294, 12" to 36" pipe, Specification for Corrugated Polyethylene Pipe.
4. ASTM C 478 - Specification for Pre-cast Reinforced Concrete Manhole Sections.
5. ASTM C 923 - Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Laterals.
6. ASTM C 443 - Specification for Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets.
7. ASTM F447 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.
8. ASTM C 150 - Specification for Portland Cement.
9. ASTM C 33 - Specification for Concrete Aggregates.
10. ASTM A 185 - Specification for Steel Welded Wire Fabric for Concrete Reinforcement.
11. ASTM 615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
12. ASTM A 536 - Specification for Ductile Iron Castings.
13. ASTM D 698 - Test Method for Moisture Density Relations of Soils and Soil-Aggregate Mixtures using 5.5 lb. (2.49 kg.) Rammer and 12 inch Drop.
14. ASTM D 1869 - Specification for Rubber Rings for Asbestos-Cement Pipe.
15. ASTM D 2321 - Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
16. ASTM C 891 - Practice for Installation of Underground Pre-cast Concrete Utility Structures.
17. ISPWC – Idaho Standards for Public Works Construction – current edition.

B. Section Includes:

1. Geotextile filter fabrics.

1.3 SUBMITTALS

A. Product Data under provisions of Division 1:

1. Geotextile filter fabrics.
2. Submit manufacturer's installation instructions under provisions of Division 1.

3. Project Record Documents
 - a. Submit documents under provisions of Division 1.
 - b. Accurately record location of pipe runs, connections, catch basins, cleanouts, and invert elevations each day.
 - c. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities each day.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements
- B. Conform to Idaho Standards for Public Works Construction and the City of Boise codes for materials and installation of the Work of this Section.
 1. Comply with applicable portions of all environmental agency regulations pertaining to storm sewerage systems.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Soil materials are specified in Division 31 Section "Earth Moving."

2.2 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.
- B. Structure Type: Nonwoven, needle-punched continuous filament.
 1. Survivability: AASHTO M 288 Class 2.
 2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.3 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of sand trench. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 3 inches.
- D. After satisfactory testing, cover sand trench to within 3 inches of finish grade.
- E. Wrap top of sand trench with flat-style geotextile filter fabric, overlapping edges at least 4 inches.
- F. Fill to Grade: Place satisfactory sand fill material over filter fabric. Place material in loose-depth layers not exceeding 3 inches. Thoroughly compact each layer. Fill to finish grade.

END OF SECTION 334600